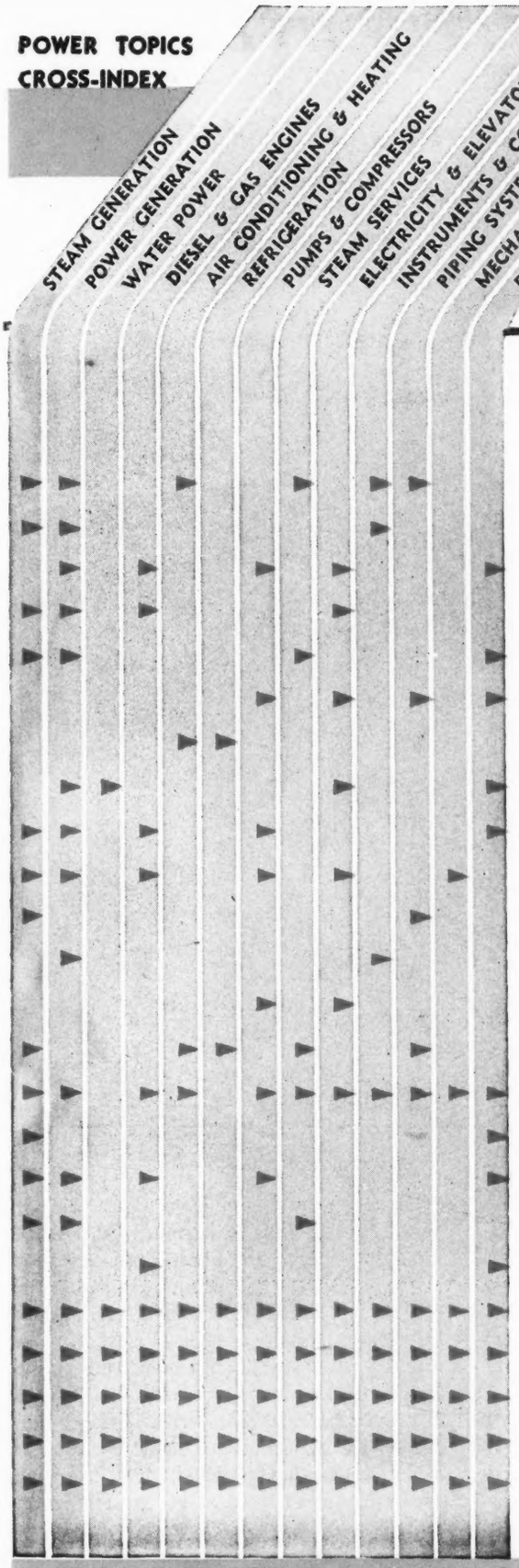

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MAY, 1937

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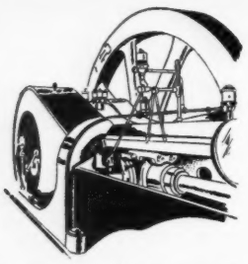
RIGHT DOWN YOUR ALLEY



One Year of Operation Shows 40% Saving with Stanocyl

Accurate oil consumption records are the only logical means for determining whether or not you *are* getting lowest cost lubrication.

A large Northwestern power plant operating a Poppet Valve Engine on a 200 K.W. generator and a Corliss Valve Engine on a 75 K.W. generator, kept accurate records of cylinder and engine oil consumption based on the actual K.W. output for each year.

On this basis Stanocyl "D" was tested for one year in competition with past records of other oils. In total gallonage it appeared that Stanocyl "D" consumption ran high because of the increased output that year, but based on cost per K. W. it actually showed a 40% saving in cylinder oil.

A Standard Lubrication Engineer will be glad to cooperate with you in making such tests. Perhaps there are very worthwhile savings that Stanocyl and other Standard products can make for you. It's a simple matter to find out.

NONPAREIL TURBINE OIL
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STANOILS—SEVEN GRADES
SUPERLA GREASES
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For further Information on

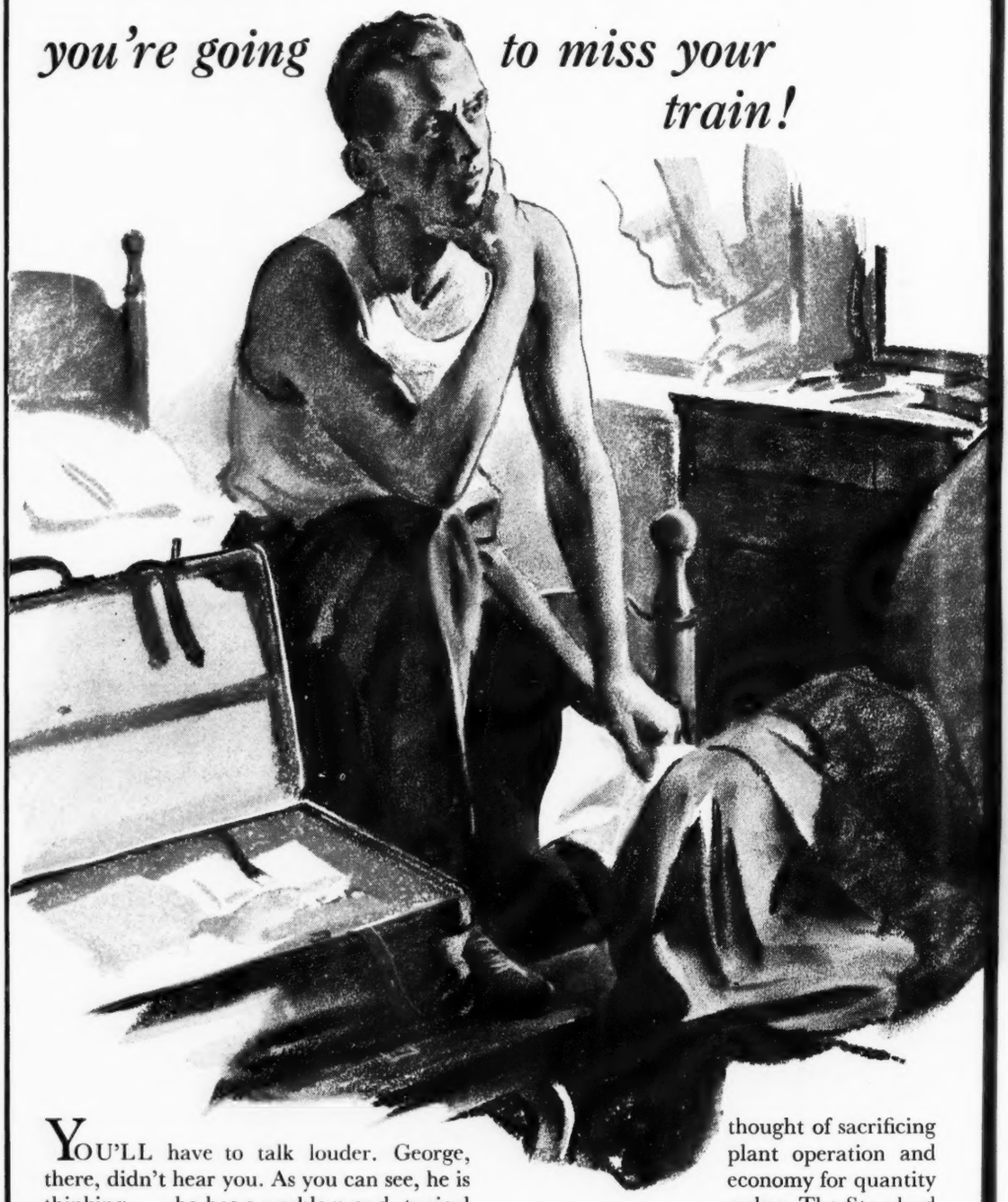
"STEAM ENGINE LUBRICATION"

An interesting monograph under this title has been prepared by Standard Lubrication Engineers to help you analyze lubrication methods and lubricants for reducing steam engine lubrication costs. It discusses operation under various steam conditions—wet, dry or superheated steam—Water Contamination—Location of Oil Feed—and other details of both Internal and External lubrication. This booklet or those listed below are yours without obligation. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago, Illinois.

"How to Cut Coal Handling Costs"
"Steam Turbine Lubrication"
"Lubrication of Shovels and Draglines"
"Service Test of Diesel Oils"
"Diesel Engine Air and Fuel Cleaning"

HEY, THERE...

you're going to miss your train!



YOU'LL have to talk louder. George, there, didn't hear you. As you can see, he is thinking . . . he has a problem and, typical of a Standard Oil Lubrication Engineer, *that* is the most important thing in his life right now.

The problem, we'll explain—if you don't feel like looking over George's shoulder—is to design a new oil feed that will lick a tough job of lubrication in the plant of one of his clients. George knows it can be done—it *must* be done, because he himself suggested it to the plant manager.

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STANDARD OIL COMPANY (INDIANA)

CORRECT LUBRICATION

A McGRAW-HILL PUBLICATION—ESTABLISHED 1882—PHILIP W. SWAIN, EDITOR **Power**

We predict . . .

As a stimulant to the imagination of engineers, we venture to set down here certain things that seem likely to happen in the American power field during the next ten years.

FORCED CIRCULATION

At least six types of forced-circulation boilers have made substantial progress in Europe—Velox, La Mont, Benson, Loeffler, Sulzer and the recently standardized Russian once-through boiler. America already has Steamotive and may expect a steadily increasing interest in forced circulation.

OIL SPRAY

Spraying steam coal with a gallon or so of oil per ton to lay dust, improve combustion and prevent fires in storage is not a new idea, but recent experiments point to more extended use in the near future.

BETTER LUBRICATION

In quality and quantity the present-day research work of big oil companies is amazing. Their aims are better lubricants and fuels, better application of lubricants, more intelligent design of machines to be lubricated. We cannot guess the exact nature of the resulting benefits, but important results *will* appear if the history of scientific research is any guide to the future.

FLUE-GAS WASHING

Not all will agree, but we feel that the United States may soon begin to track England's footsteps in the matter of more thorough scrubbing of flue gas and wider application of gas scrubbing. We do not, however, look for any grand rush in this direction in the near future.

PROCESS APPLICATIONS

In the process field it seems likely that the direct cooling of processed liquids (including liquid foods), by evaporation under high vacuum, will grow. There will also be many new applications of "Program Control" in which a complex series of variations of pressure, temperature, speed, etc., is run off automatically "by the book."

AIR CONDITIONING

For once the public is right. They say "air conditioning is the coming thing" and it is. Probably the average householder won't be able to afford real air conditioning as soon as he fondly hopes, but he will cirtainly find plenty of it in offices, factories, public buildings, hotels and institutions. The boom in air conditioning will create a great market for pumping equipment, fans, ducts, regulators, refrigerating machines—perhaps for diesel engines, also.

DIESELS

And of diesels there is plenty to say. Here, too, as with air conditioning, we have the newspaper ballyhoo. It is not the cure-all for every ill of power supply, as is sometimes implied, but it has a very real future. That future does not lie in the large central power plant, except perhaps for standby and auxiliary drive. But for small- and medium-sized power, particularly where process and heating steam loads are not heavy, the diesel is a very good bet.

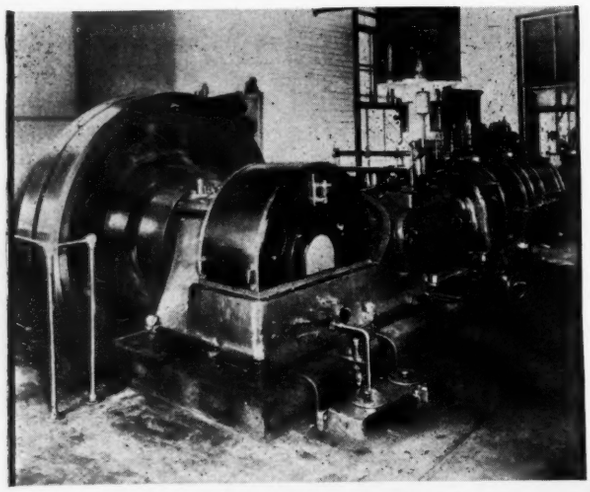
The greatest single factor in promoting power-plant use of diesels will be their wide use outside of power plants. Applications to tractors, construction equipment, trucks, etc., will lead to mass production and a low-cost engine which will work as well as for the power engineer.

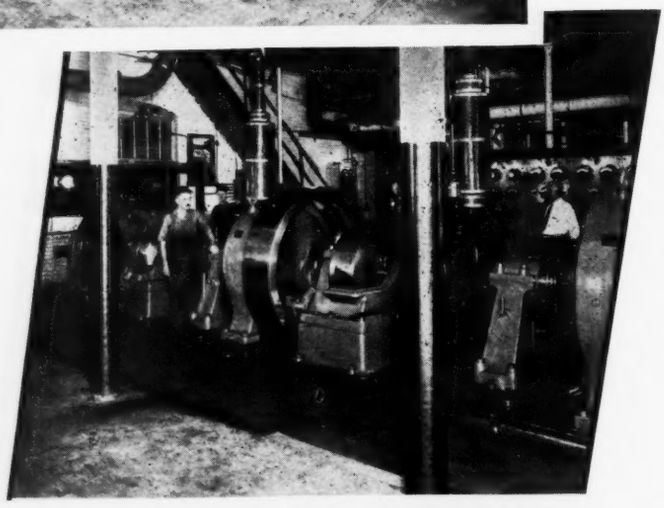
Except in the larger sizes, diesel users will get away from custom-built jobs. Economy in first cost demands buying standard units "off the shelf." Recently improved schemes for automatically starting, loading and stopping individual units in multi-unit plants hold great promise.

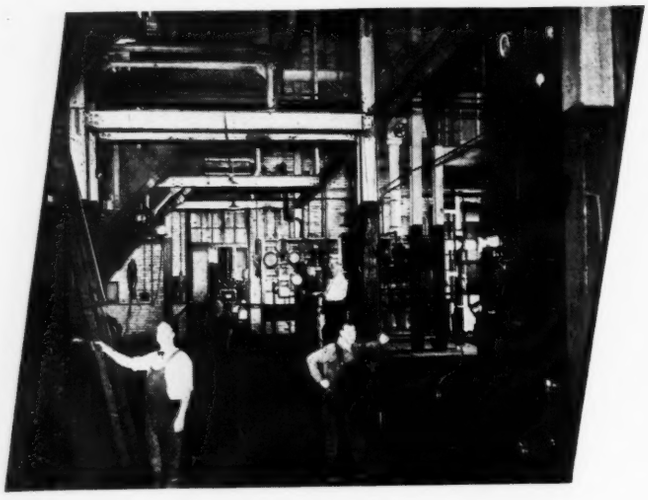
New Hampshire Pays Its Way

Instead of arbitrarily slashing power-plant budgets, New Hampshire brought in a consultant and found ways to save money. Here he tells how it was done

By C. H. Camp
Consulting Engineer for State of New Hampshire







STATE HOSPITAL — Top: Skinner Unaflow and 225-kw. Crocker - Wheeler generator. Center: .Three Westinghouse generators direct-connected to Ridgeway engines. Bottom: One old boiler at right: new boilers at left. All photos by Kimball Studio

NEW HAMPSHIRE suffered from loss of income during the depression quite as much as any of our States, if not more severely. It became necessary to obtain greater efficiency and economy in public institutions or to take the easier way out of slashing appropriations, which would have seriously impaired the essential services. The problem, then, was to use engineering as a major factor in budget balancing by gaining substantial savings and in so doing, also to raise standards of service.

While some excellent groundwork had previously been done in some plants, it was felt that greater economies could be secured all along the line. Therefore, the then governor, H. S. Bridges, now U.S. Senator, appointed an engineer specialist with knowledge of fuels and fuel-burning equipment, as fuel constituted a major item in operating expense. Savings were intended to improve the State's finances, yet it was fully realized that a great deal of modernization would be required to reach maximum efficiency. When possible, more efficient equipment was purchased, but these purchases were infrequent and always based on actual necessity or quick amortization.

In the main, savings had to be secured by selecting the most suitable coals, using the most economical methods of firing and of operating existing power, heating, lighting and hot-water equipment, and making alterations and repairs to stop leaks and losses. Tests on a number of coals have been made with both hand- and stoker-fired equipment, and will be continued until the relative "this-plant value" of each type of coal commercially practicable in New Hampshire has been established. It has already been conclusively established that, because of extraordinarily high freight rates here, the improved performance of high-grade coals substantially overbalances their higher cost.

Some of the beneficial processes partly or entirely completed in the nine public institutions are: zoning and orificing of heating systems; changes in size or location of radiators; maintenance of heat above chill point over nights and week-ends during cold weather instead of banking fires (sleeping rooms are regulated individually); admission of minimum pressure to lines during warming-up periods; increase in feedwater temperature by improved arrangements and sizing of exhaust and return lines; use of better insulation; and selection of coals for hand-fired plants that permit long firing periods and

little working with minimum open-fire-door time.

In the first year, more than $20,000 was saved, with a yearly coal consumption of less than 30,000 tons. The usual avalanche of service complaints has been brought to a negligible point—none at all from deficiency of power, steam or hot-water supply. Five of the nine institutions had their first year of continuously adequate heat. And all of this with an exceptionally severe winter.

In describing two institutions, one stoker-fired and the other hand-fired, I shall try to show what was done to improve efficiency. The New Hampshire State Hospital has 33 buildings spread over 500 acres. An individual community, it has all the requirements—buildings different in construction and function and spread out from the plant, wind- and light-shielding buildings, and wooded sections.

Former Plant

Steam had been generated for a number of years with eight h.r.t. boilers, each having 1,670 sq.ft. of heating space, Perfection stokers, and 40-in. combustion space. Rapid enlargement of the hospital made it necessary to replace five of these with three 3,370-sq.ft. Heine boilers. The remaining three h.r.t.'s were raised as much as space permitted, providing 6 ft. of combustion space, and a V-projection, 20 in. long, with its center slightly lower than boiler bottom, was installed on each rear combustion wall to improve combustion and mixing of gas. These changes improved capacity of the h.r.t.'s 20% and their efficiency 10%.

Heine boilers have Westinghouse multiple-retort stokers, Buffalo Forge Co. optional-turbine or electric-driven pressure and induced-draft fans, Foster-Wheeler economizers, and Hagan combustion control. 3-pass baffling is used, with the first pass of gas being deflected tangentially to the boiler front. Heating surfaces are Apexiorized; supplementary equipment consists of Stets feedwater regulators, Schutte-Koerting non-return valves, and Vulcan soot blowers. A 100-ft. Custodis stack services the entire plant. All boilers operate at 140 to 150 lb.

Feedwater first passes through a Hoppes deaerating V-notch heater, in which a temperature of approximately 212 deg. F. is obtained. This, depending on load conditions, is raised to 330-355 deg. in economizers. Meter equipment consists of Brown flowmeters, Foxboro load indicators and 3-point draft indicators, and Hays CO_2 indicators and recorders. Flowmeters on mains for each group of steam usage enables accurate analysis of the efficiency of different equipment, arrangements and methods of operation. Properly placed thermometers permit keeping accurate degree-day records.

No one realizes better than Supervising Engineer E. A. Staples and his efficient staff that improved results are made with understandable records.

Coal is flop-dumped from trucks through a number of openings in a platform to a storage bin, and from there conveyed to overhead bins, from which a Jeffrey larry equipped with Richardson scales conveys it to stoker hoppers. Ash is removed by a vertical bucket conveyor into an outside hopper. From coal truck into ash truck, no outside work is necessary nor is coal or ash exposed to weather.

STATE PRISON—Top: Individual pressure regulation to one of six zones of heating system. Center: Main cell block, showing zoning. Bottom: Boiler room. All photos by Kimball Studio

Changes in stokers have been made to reduce and zone over-fire air to suit the locality's best available coals from a combined economy-load-handling standpoint. Relative "this-plant value" of a number of types of coal has been established. All other commercially practicable types available in

the district will be tested, and ultimately, "this-plant value" of all coals deemed feasible for various types of plants will be established.

Almost all electric current is generated with a 225-kw. Crocker-Wheeler d.c. generator direct-connected to a Skinner Unaflow engine. Three Westinghouse generators of 100-, 75- and 50-kw. capacity, direct-connected to Ridgeway engines, take care of low-load periods or assist during heavy-load periods. The institution, now far flung, requires a change over to a.c. for economy, and when this is done, all uniflow engines are contemplated.

The refrigerating plant is made up of a 50-ton Carbondale compressor and two Blake & Knowles brine pumps. Spring water, at 40-45 deg. throughout the year, is pumped by a Smith-Vaille unit for cooling ammonia. All important pumps and other service units are in duplicate for safety, and are all operated with automatic regulation at best points of adjustment. Water is now heated with exhaust steam instead of live steam.

All buildings are zoned, some having two or three different pressure zones. Considerable orificing of individual radiators has been done and a continued study of this plus size and location of radiators is being made. A 33% increase over load previously carried has been absorbed without any increase in coal consumption, and use of more suitable coals has, in itself, resulted in 8% higher boiler efficiency.

The State Prison, with its hand-fired boilers, is an excellent example of coordinating a locality's economically best coals and plant. Enlargement of the institution had increased load to a point beyond either good service or economy, and proper selection of coal was reduced to a very narrow range. With the old system of accepting lowest bids on a specified chemical analysis basis, securing satisfactory and economical coals was rarely possible—in this particular case it had never occurred.

A careful survey was made and laid before Deputy Warden Knight and Warden Charles B. Clarke, who then and since have given every support possible for improvements. Two 72x18-ft. h.r.t. boilers were gallows-suspended, which eliminated excessive air infiltration and expensive repair bills that had been caused by walls cracking because of insecure foundations. Grate openings were increased from $\frac{1}{2}$ to $\frac{5}{8}$ in. and bridge walls built higher. Conditions above and below boilers unfortunately prevented increasing height of combustion space, but, nevertheless, a substantial gain was made in efficiency and steaming capacity.

An additional condensate tank was installed, which eliminated spasmodic flood-return of condensate and the former loss of 50% of returns to the sewer. This loss had been made up with cold water direct from supply mains, resulting in low efficiency, extra boiler stress and difficult steaming. And, of course, cost of water had been excessive.

Zoning of both heating and process units was then effected with individual trapping for all coils and process units. This meant that we could prevent backing up of condensate in lowered-pressure units until a flood stage of hydrostatic head brought balance adequate for release (after condensate had been considerably chilled), a condition that had continually occurred when drains were piped to a group receiver or trap. Poor pipe insulation was brought up to standard throughout the plant. At present, return of condensate is steady and averages approximately 200 deg. F.

More and more improvements made it possible to operate the boilers at economical ratings and to widen the range of suitable coals. Types of coal new to this plant were tried, proving much superior to ones previously used. Substantial savings were made with the coals themselves, and their characteristics were such that, together with elimination of the need for extreme forcing of fires, the most economical firing methods could be put into effect, resulting in further gains.

We have made a continued study of all power, lighting, hot-water and steam-heating equipment and have improved arrangements and methods of operation whenever possible. As a result, it has been possible to supply hot water to each cell. The 20% additional boiler load was easily absorbed, which could not even have been considered formerly.

Savings of over 20% per degree-day have been attained and boilers, per unit of work, now require 12% less coal. However, to the believer in the broader aspects of engineering, the greater achievement is the help that all of this has given to Warden Clarke's objectives. We all know that a well-operated mechanical department, striving continually for most efficient results and maintaining equipment in the proverbial apple-pie order, will do much, both by example and maintaining of satisfactory conditions, to elevate spirit and morale of an entire industrial or institutional personnel.

The engineering profession may well take pride in the major part it has in the proper functioning of educational, curative and correctional institutions. Together with the profession of architecture, it provides progressive improvement of the facilities necessary for the advancement of institutional work; by progressive improvement of economies, it makes these facilities more readily available.

Rest in Pieces

Our fireman, old Benjamin More
Liked to sleep, and sleeping, to snore
He napped on the flooring, the chief heard his snoring—
Now Benny don't work here no more.

Oil savers designed by Chief Teazles
Were installed on his company's diesels
They had one tiny quirk—they just wouldn't work—
No oil, no bearings, wrecked diesels.

Chief Engineer Duncan MacDougal
Had grown exceedingly frugal
He quit buying paint; now his steelwork just ain't—
And rust's made a bust of MacDougal.

Evolution of a Steam Plant

By John Zogelmann and *W. G. Johnson*

Chief Engineer Wolf River Paper & Fiber Co. *President, Dual Combustion Corp.*

Wolf River Paper & Fiber Co., Shawano, Wis., reduced yearly fuel bill from $99,000 to $54,000 by four succeeding changes in plant equipment

THIS ARTICLE is a chronological report of improvements to a steam power plant that started with an investment of $500 for combustion instruments and ended with the installation of a top-pressure plant costing $53,785.

In the early part of the depression, with the aid of a steam-flow meter and hand-operated combustion instruments, a systematic study of steam cost was begun. At this time, the plant contained three 3,000-sq.ft. Lions h.r.t. boilers and one compound-condensing engine in the sulphite plant. In the paper-mill plant were four 1,500-sq.ft. h.r.t. boilers and three non-condensing engines, one of which was connected to a 150-kw. belted generator. This engine also drove a main-line shaft, that drove beater and stock-pumping machinery. The plant produced approximately 50 tons of pulp and paper daily.

In the wood department, which prepared the pulp stock for the digestors, were three water-wheel-driven generators. All generating equipment of the three plants was synchronized, feeding into a single system of cables, and furnished all necessary power and steam for process.

In the original plant steam pressure was between 110 and 120 lb., no superheat was available, and all firing was done by hand. Average boiler efficiency was 52% and the plant consumed approximately 1 lb. of coal per lb. of pulp and paper produced. Boilers were operated at an average boiler rating of 107% and necessarily burned a high-grade eastern screened coal. Boiler age ranged from 20 to 25 years and, in spite of comparatively low ratings, maintenance cost was high because of small combustion chambers.

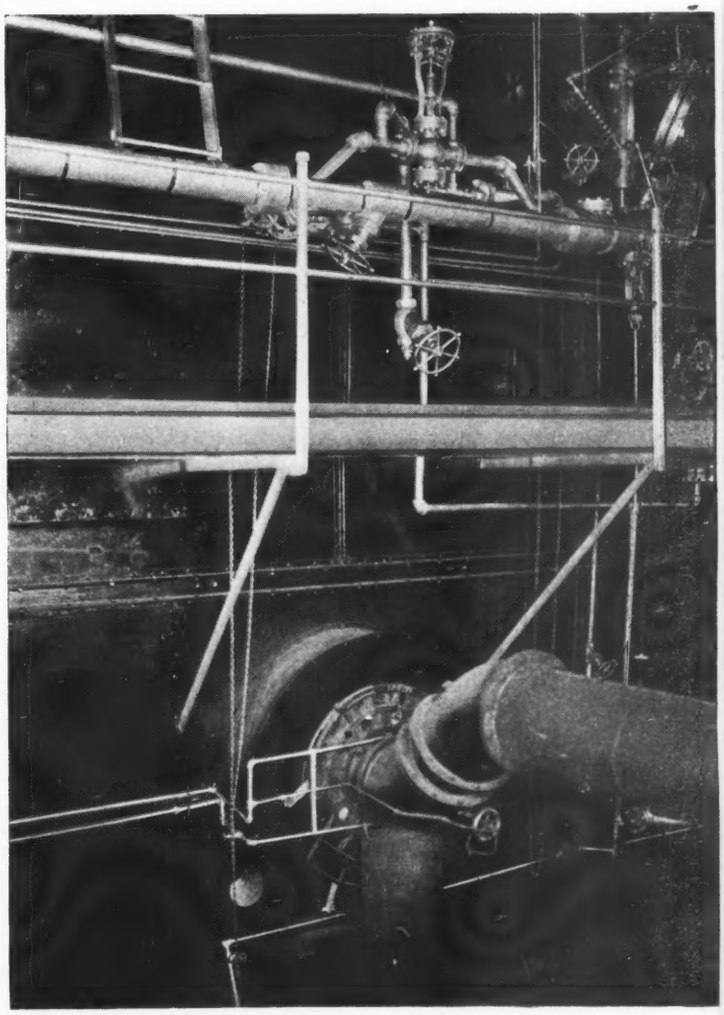
The first steps were to improve the combustion chambers, change the draft-control system, increase feedwater temperature and decrease loss of hot-water that drained from the hot-well overflow. First year's results, on this new basis, saved the mill, on an equal production of pulp and paper basis, a little over $17,000, and reduced coal consumption from 2,000 lb. per ton of pulp and paper to 1,730 lb. Average boiler efficiency was increased from 52 to 59.8%. These savings can be attributed to the installation of a flow meter and combustion instruments.

The following year, the management decided to install two over-feed stokers that were purchased on the basis of savings to be made through purchase of a cheaper grade of coal. It so happened, however, that because of stoker-operation methods, coal consumption increased from 1,730 to 1,896 lb. per ton of pulp and paper. However, a drop in price of coal from $5 per ton to $4.49, made possible a saving of $367.00.

Operation of the stoker was greatly improved the following year by reducing over-fire draft and preventing leakage of coal through grates. This greatly decreased carbon loss back of the bridge walls, in the breeching and at the stack. Efficiency, which had dropped to 54.6%, increased to 64.4%. Coal per ton of pulp and paper dropped from 1,896 to 1,608 lb. However, because of increased coal costs, the annual fuel bill decreased only $2,100.

Early in 1935, it was decided to take advantage of latest steam-power improvements. By the use of high-pressure steam and a high back-pressure turbine which could be synchronized with present equipment, the greatest economy was thought possible. After a study of requirements for power and process, a 500-kw. top turbine was installed to operate at

Fig. 1—Boiler front showing feedwater regulator and burner



an initial pressure of 310 lb., and 100 deg. superheat. It was arranged to exhaust into a 100-lb. header which was also connected to all of the existing h.r.t. boilers. This header now furnishes steam to the reciprocating engines and digesters in the pulp plant.

The steam-generating unit consists of a pulverized-fuel-fired, water-tube boiler having 4,000 sq.ft. of heating surface designed to operate at

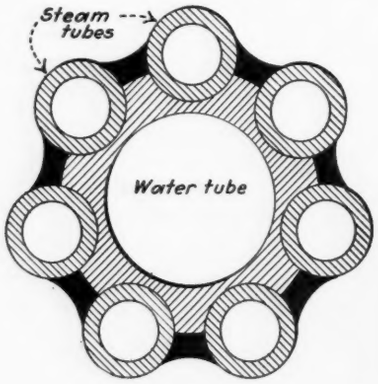


Fig. 2—Cross-section of superheater

250% rating. Drums are fusion-welded. The front bank of tubes, or what is commonly known as the first bank, is split as shown in Fig. 3 to allow firing of pulverized coal through this bank into a large secondary combustion chamber in the rear. This air-cooled combustion chamber is designed to afford a 36-ft. flame travel from the burner to the first bank of convection tubes and to allow a large combustion space with a release of about 15,000 B.t.u. per cu.ft. The boiler has been on the line for approximately one year without refractory maintenance cost, and has operated at an average of 215% rating during this run, with an average of 15% CO_2.

Superheater

A feature of the boiler is the superheater, which has been taken out from among the boiler tubes and placed directly across the furnace in the hottest spot. Steam tubes are clustered around a water tube, Fig. 2, which is supplied at its lower end with water from the mud drum and connected at its upper end to the steam drum. By controlling water level in the inner tube, steam temperature can be kept within 1 deg. of desired temperature. A quick fire can be easily built without danger of burning the superheater steam tube. It was aslo found that the temperature can be controlled at any boiler load and give a straight line curve.

This superheater is a radical departure from the conventional type and has operated as represented. It can be drained, cleaned and regulated, and there is no possibility of burning it up by bringing the boiler up to steam too rapidly, or by suddenly shutting off steam from the boiler. An air preheater, designed to heat air to 375 deg., is located alongside of the secondary furnace, and contains 2,000 sq.ft. of heating surface. Draft drop across the preheater ranges from 0.05 to 0.07 in. of water, making unnecessary use of induced draft.

The feedwater is pumped to the boiler by a turbine-driven, 4-stage centrifugal pump. Auxiliary feedwater pump is a duplicate with electric drive. Feedwater is softened with Zeolite and its temperature raised in closed and open heaters.

Concentration of salts in the boiler is controlled automatically with continuous blowdown equipment, and loss of heat is prevented by a heat exchanger. A de-aerating open feedwater heater removes all oxygen from the feedwater. This system has been found so successful that, after a year's operation, the boiler is free of scale, there is no carryover to superheater tubes and no corrosion inside the boiler.

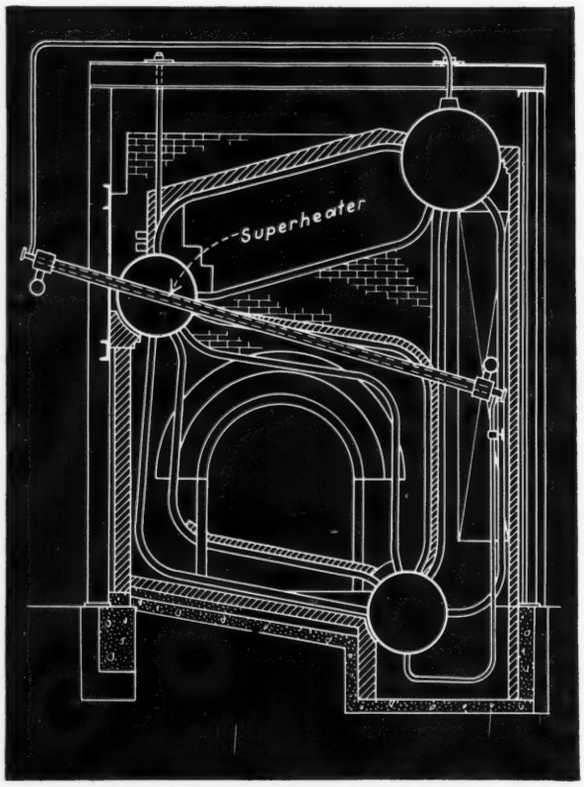


Fig. 3—Boiler cross-section showing location of superheater

A single pulverizer was installed, capable of grinding 4,000 lb. of coal per hr. to a fineness that will pass 99% through a 100-mesh screen and 65% through a 200-mesh screen. Power required is approximately 12½ kw. per ton of coal. Pulverizer feeding mechanism is oil hydraulic driven. Coal-feed is controlled by micrometer hydraulic valves. Repair cost to the pulverizer grinding members averages 1.2 cents per ton.

Starting up of a cold boiler is made simple and positive by the accuracy of air and coal-feed controls, together with the indicating electrical controls. It generally requires less than 3 min. to produce a steady flame and less than 5 min. to bring CO_2 up to 15%. Burners are of the short-flame turbulent type and provided with short ignition chambers that can be heated with a small kindling fire for starting. Ash is removed, either while boiler is in operation or idle, by a hydraulic-jet system.

The new 500-kw. turbine has five stages exhaust-

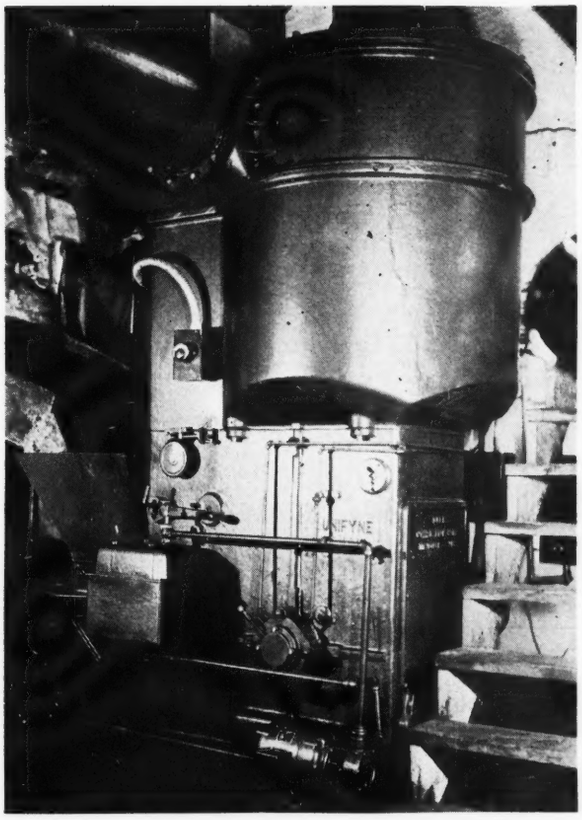


Fig. 4—Pulverizer feed by hydraulic feeder

ing at 100 lb. pressure. It is interesting to note that the turbine extracts only 71 B.t.u. from each pound of steam. Exhaust is superheated approximately 30 deg. and, under an actual test run at 63% load, it required 6,520 B.t.u. to produce a kilowatt hour. Therefore, considering the top pressure unit alone at this load, 2.1 kw. hr. per lb. of coal is produced and overall efficiency of the unit is 47.5%.

Desuperheater

A reducing valve and a desuperheater with automatic control to maintain proper steam temperature were installed so steam could be supplied to the 100 lb. header from the new boiler in case the turbine was down.

The original plan was to use the topping unit as a base-load generator and allow the compound-condensing engine to absorb the fluctuating load. However, because of extreme sensitiveness of the governor on the new turbine, it was necessary to change the plan and allow the topping unit to take the fluctuating load.

Operation of this topping unit reduced coal consumption from 1,608 lb. per ton of pulp and paper with the improved stoker-fired operation, to 1,215 lb. Average daily boiler efficiency was raised from 64.4% to 82.5% and the fuel bill was reduced from $73,000 to $53,000 annually.

The new unit has made it possible to take out of service one of the non-condensing engines and still give the plant 150 kw. more connected power than the old arrangement. It is also possible to shut down the new top-presure boiler and turbine, and run the plant at 90% capacity.

Summary of Results

Cost of 500-kw. Top Pressure Plant—$53,785.00
Cost of Pulverized Fuel Steam Units Complete—$24,000.00

	Original Hand-Fired Furnace	Improved Hand-Fired Furnace	Original Stoker-Fired Furnace	Improved Stoker-Fired Furnace	Pulverized Fuel Fired Topping Unit
Lb. of Coal per ton of pulp and paper ...	2,000.	1,730.	1,896.	1,608.	1,215.
% increase of lb. of coal per ton of pulp and paper over pulverized fuel	64.0	42.0	56.0	32.0	
Fuel costs per ton of pulp and paper	$5.35	$4.35	$4.33	$4.22	$3.06
% of increase of cost of fuel per ton of pulp and paper over pulverized fuel costs	75.0	42.0	41.0	38.0	
Fuel cost per ton of 14,000-B.t.u. coal	$5.35	$5.00	$4.49	$5.22	$5.05
Average efficiency.....	52.0	59.8	54.6	64.4	82.5
Actual yearly fuel cost adjusted to 17,350 tons of pulp and paper produced	$92,852.00	$75,492.00	$75,125.00	$73,327.00	$53,091.00
Dollars saved yearly by each successive change..		17,360.00	367.00	1,798.00	20,236.00
% yearly savings by each successive change.....		18.7	0.3	2.4	27.5
% yearly savings over old plant		18.7	19.1	21.0	42.8

REMARKS:

A top-pressure, pulverized-fuel unit doubled the combined savings of all other methods of fuel burning.

Average Operating Data

	Design Guarantee	Actual Results
Boiler-drum Pressure, lb. per sq. in.....	325	324
Feedwater to boiler, deg.....	212	192.5
Temperature of air out of furnace wall, deg.....	180	180
Temperature of air out of preheater, deg.....	375	395
Temperature of gas out of boiler, deg.....	600	625*
Temperature of gas out of preheater, deg.....	425	441
Boiler rating, %.....	200	202
Pressure—superheated steam, lbs. per sq. in.....	310	309.8
Superheat, deg.....	100	99.2
Steam temperature, deg.....	529	526
CO_2, %.....	15	14.8
CO, %.....	None	None
Smoke—Ringleman chart, %.....	10	9.1
Furnace draft, in. of water.....	.05	.052
Draft, air-heater outlet in. of water.....	.51	.38
B.t.u. of coal.....	14,000	13,738
Weight of water evaporated per hour, corrected for moisture and factor of evaporation.....		26,875
Weight of coal burned per hour, lb.....		2,312.5
Pounds steam per pound coal from and at 212° F.....	11.65	11.62
Efficiency of boiler furnace and air heater %.....	81.0	82.5

** Portion last baffle omitted because available draft lower than expectations*

Principal Equipment Installed

Furnace	Dual Combustion Corp.
Pulverizer	Dual Combustion Corp.
Air heater	Dual Combustion Corp.
Turbine	Moore Steam Turbine Co.
Generator	Westinghouse Elec. Supply Co.
Boiler	Combustion Engineering Co.
Tubes	Globe Steel Tubes Co.
Superheater	Controlled Heat Equipment Co.
Combustion instruments	Hays & Cochrane Corps.
Water-treating equipment	The Permutit Co.
Refractories	Laclede Christy Clay Products Co.
Feedwater pumps	Manistee Iron Works Co.
Feedwater pump drives	Allis-Chalmers Mfg. Co. Moore Steam Turbine Co.
Piping	Geo. B. Limbert Co.
Water gage	Reliance Gauge Column Co.
Soot blowers	Diamond Power Specialty Co.
Insulation	Eagle-Picher Co.
Steel	Worden-Allen and Moise Steel
Valves	The Wm. Powell Co., Edward Valve & Mfg. Co., Concolidated Ashcroft Hancock Co., Crosby Steam Gauge & Valve Co., Homestead Valve Mfg. Co., The Swartwout Co., Okadee, Morley Murphy
Pulverizer motors	Louis Allis Co.
Desuperheater	Swartwout Co.

Centrifugal Purifiers for Lubricating Oil

Pressure and gravity purifiers were considered in January and March *Power* respectively; here is an equivalent discussion of centrifugal units

By James I. Clower

Associate Professor of Machine Design, Virginia Polytechnic Institute

PURIFICATION of lubricating oils centrifugally is fundamentally precipitation. It employs the same basic principle as the gravity-type purifier and batch purification. Centrifuging, however, is faster because the separating force is several thousand times that of gravity and, furthermore, is more effectively utilized.

As in batch-treatment and gravity purifiers, the relative position of oil and various impurities depends on their densities. Fig. 1 represents a stationary, shallow vessel containing a mixture of oil, water and sludge. The only force acting on the mixture is gravity. Because of differences in specific gravities of these substances, if permitted to stand quietly they separate as shown. Fig. 2 shows the same vessel rotated at high speed about its vertical axis. The mixture is now subjected to centrifugal force as well as gravity; the former being as much as 64,000 times the latter in some modern centrifuges. In Fig. 2, oil, water and sludge are arranged as in Fig. 1, but in vertical planes instead of horizontal ones.

Neglecting turbulence, the thinner the layer, the quicker separation will occur as the impurity travels at the same rate. This principle is embodied in actual centrifuges by two separate and distinct designs. In Fig. 3, liquid depth is reduced to a minimum by using a long, small-diameter bowl. The theoretical path taken by a solid impurity as the mixture flows upward through the bowl is in an inverted spiral. The practical path is nearly a straight line to the outside of the bowl, as commercial bowls have a 3-wing blade to prevent swirling and shorten the effective distance the impurity must travel. The heavier the impurity, the quicker it is thrown out. Consequently, the heaviest impurities collect near the bottom where dirty oil enters the bowl.

The center of the bowl is occupied by a solid cylinder of oil with an air space in its center, while water surrounds the oil in the form of an

Fig. 1—Principle on which a gravity oil filter operates. Fig. 2—A centrifugal purifier operates on the same principle as a gravity, but the forces acting to separate impurities are many times greater, and oil water and sludge are arranged in vertical layers. Fig. 3—Centrifugal purifier with long, small-diameter bowl in which oil is separated from impurities. Fig. 4—Oil in this centrifugal purifier is divided in thin layers by disks to increase rate of separation

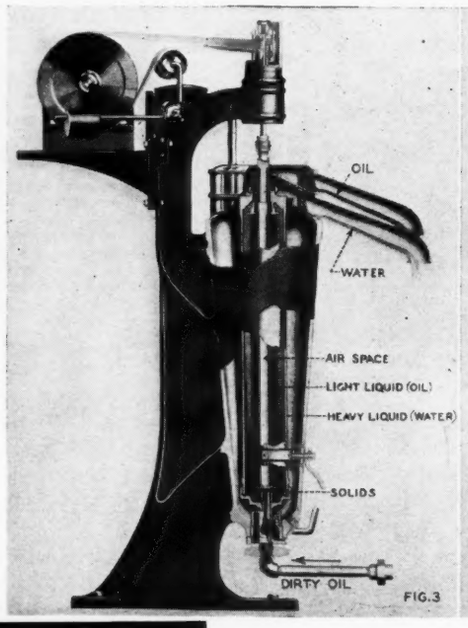


FIG. 3

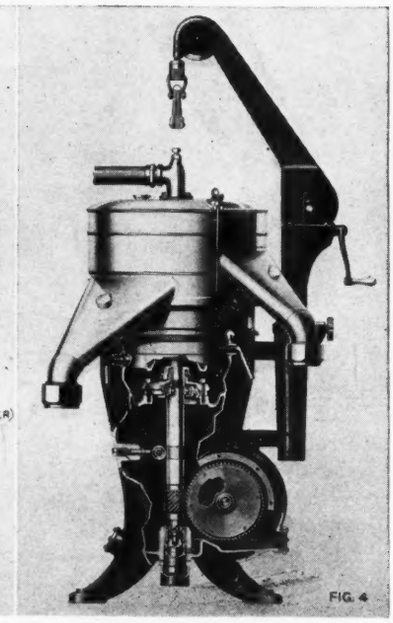
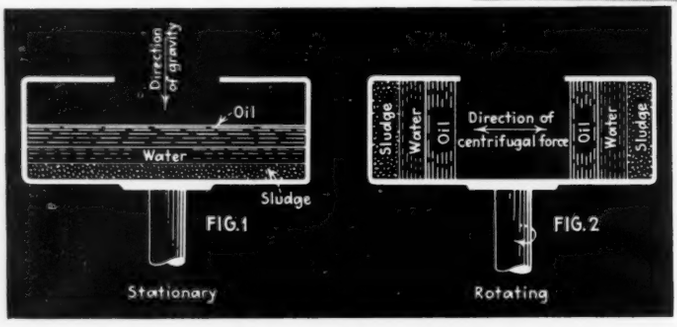


FIG. 4



annular cylinder and impurities are deposited against the inside surface of the bowl. At any point static pressure upward equals that downward. Oil being lighter than water requires a higher head in order to balance that of the water. The amount of water or oil held in the bowl at any one time can be governed by varying the difference in the head between the oil and water. From the foregoing it is obvious that this head governs the radial position of the line of demarcation between oil and water layers in the bowl.

Practical advantages of such a design is the high efficiency of the non-turbulent streamline flow of liquid (providing a short direct path for the impurities to travel directly away from oil flow), and the ease of cleaning and handling the bowl.

Figs. 4 and 5 show a design very different from that in Fig. 3, but based on the same fundamentals. The object of both is to remove impurities in the shortest possible time and in minimum space.

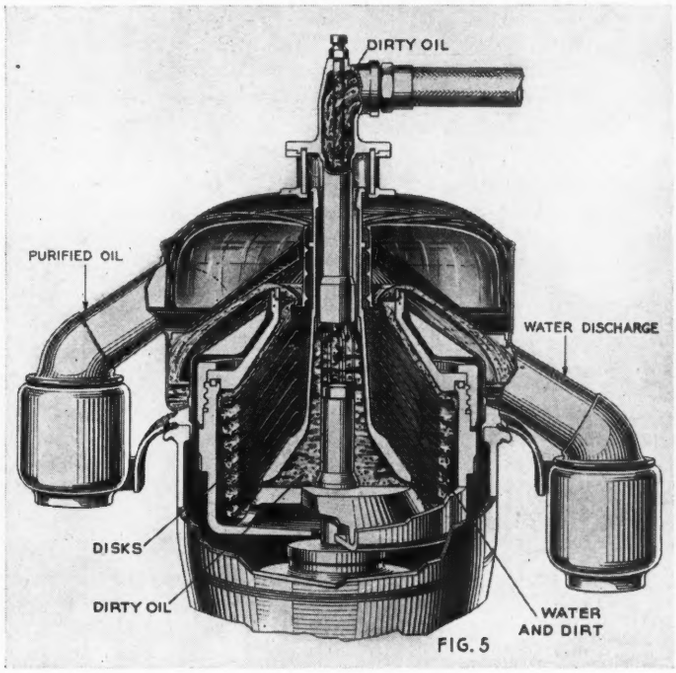


FIG. 5

Fig. 5 is a cross-section of a bowl similar to that used on Fig. 4. In the bowl and rotating with it are frustrums of cones or disks that divide oil in thin layers and direct its flow. These cones speed up rate of separation, having the same effect as using a shallow gravity tank instead of a narrow deep one. Holes near the base of the cones permit flow up through them as indicated. Dirty oil flows in at the top and down a central pipe into the bowl. As it rotates with the bowl, centrifugal force causes oil to flow to the bottom.

As oil works its way up through holes in the cones, water and other impurities are thrown to the outside and cleaned oil flows up between cones to a passage way surrounding the central incoming pipe and out into the purified-oil discharge. Water thrown to the side of the bowl is forced up by the higher head of oil, and overflows into the water discharge. Fig. 4 shows how a centrifuge of the type in Fig. 5 is driven by a motor geared to the lower end of the shaft on which the bowl is supported.

Fig. 6 is another design of centrifuge. Dirty oil is pumped into the centrifuging bowl and purified oil is delivered to the lubrication system or to storage by another pump. Flow of oil through the equipment is clearly indicated by the arrows.

The term capacity, as applied to centrifuges, is

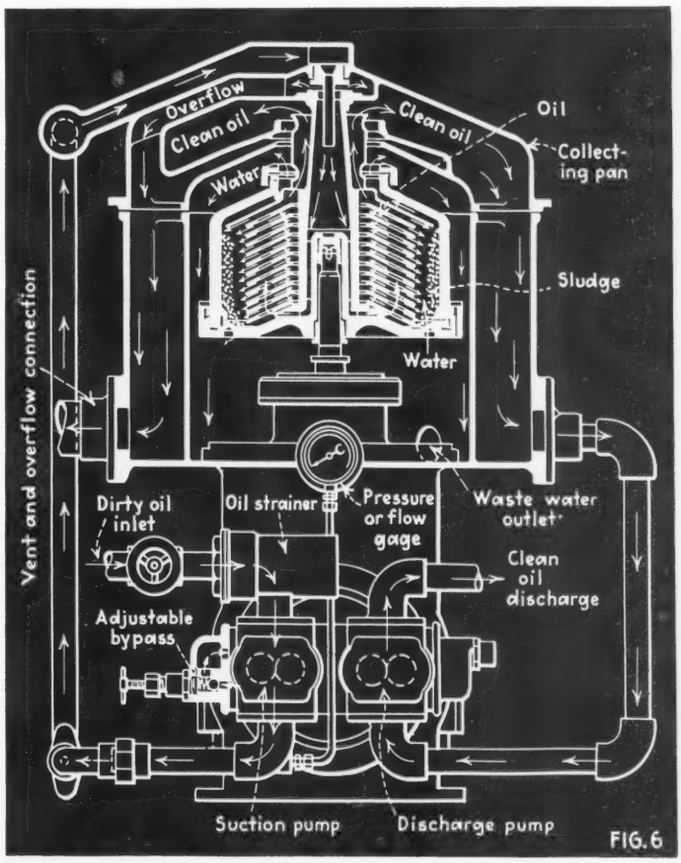


FIG. 6

Fig. 5—Cross-section of bowl for centrifugal purifier, Fig. 4. Fig. 6—Dirty oil is delivered to this centrifugal purifier by one pump, and clean oil is discharged to the lubricating system or storage by another pump. Figs. 7 and 8—Cross-sections through heater for diesel-engine lubricating and fuel oil, using exhaust gases as the heating medium

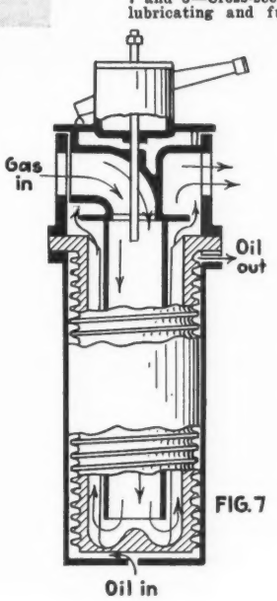


FIG. 7

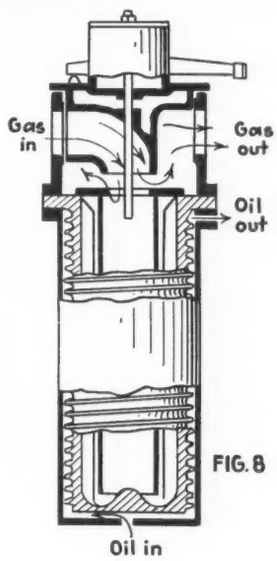


FIG. 8

often used loosely. A centrifuge may be said to have two capacities:

1. Through-put capacity, which is the total quantity of oil that may be put through the machine regardless of the degree of purification effected and without overflowing.

2. Effective capacity, which is the quantity of oil that may be put through the machine with the desired degree of purification.

Effective capacity generally has no relation to through-put capacity. For example, a certain machine has a through-put capacity in excess of 450 gal. per hr. while its effective capacity is between 200 and 300 gal. per hr. Obviously, through-put capacity is of little importance, while effective capacity is a major consideration to the user.

Effective capacity depends on many factors, the most important being viscosity of the oil undergoing purification; temperature of the oil; amount, size, weight and other characteristics of the impurities; degree of purification desired or required; and persistency of emulsion if water is present.

It is obviously impossible to evaluate all factors in advance of installation, hence impossible to state that a certain machine has a definite capacity in so many gallons per hour. A capacity-temperature chart can be prepared to take care of viscosity and temperature, but not for the characteristics of impurities, degree of purification required, persistency of the emulsion, etc. In consequence, builders of these machines generally give effective capacities over a rather wide range, which frequently show variations between the minimum and maximum capacities as much as 100%.

Effective Capacity

In general, the effective capacity of a centrifuge should be such as to render it possible to handle the entire batch of oil in the system every 2 to 6 hr., depending on the degree of purification desired and the operating conditions. Given in the table are effective capacities recommended by one builder for diesel-engine service.

Centrifuge capacity may be increased by heating the oil before introducing it into the machine. Since all oils become less viscous upon heating, less resistance is offered to the passage of impurities through the oil, thus separation is quicker at elevated temperatures. It is general practice to heat oil to a temperature between 160 and 180 deg. F. before running it into the machine.

Where heating is practiced, it is usually done by means of exhaust gases in diesel installations, electrical heaters, or steam coils. An increase of 30 to 40 deg. F. will about double the rate of purification. If an oil contains solid impurities only, such as metallic, dust, and dirt particles, it may be purified faster than if water and minute carbon particles and soluble sludge are present.

Figs. 7 and 8 show an oil heater for diesel lubricating and fuel oil, using exhaust gas from the engine. Oil to be heated flows into the bottom of the heater and upward along helical grooves in the outside of the heat exchanger, enclosed by a smooth casing. Exhaust gas flows down a central tube and then in a thin layer along the inside of the exchanger. To control flow of gas through the heater, the central tube is raised or lowered. In Fig. 8, all gas is bypassed around the heating element. Flow of gas through the heater is not cut off, but allowed to flow to prevent cooling and condensation in the piping connections. In actual operation, the position of the tube baffle is either thermostatically controlled and operated by an oil cylinder and piston, or manually controlled to maintain proper oil temperature.

Centrifuges are said to operate as clarifiers when they are employed to remove mainly solid impurities and little if any water from the oil. In this case the discharge is a single effluent—purified oil. When they are used to remove both solid impurities and a considerable amount of water, they operate as separators and discharge two effluents—purified oil and water. In general, the same machine may be used either as a clarifier or as a separator by making a simple adjustment.

Dirt and sludge retained in the bowl should be removed at regular intervals. Generally once or twice a day is sufficient, depending on the quantity of impurities in the oil. Furthermore, all internal parts of the bowl should be cleaned periodically and rinsed in hot water.

Centrifuges, of course, will not separate liquids that are mutually miscible. For example, they will not remove diluent or kerosene from lubricating oils. For this reason centrifugal purification has little if any effect on viscosity, flash and fire points. Unlike filters, the efficiency and capacity of a centrifuge does not appreciably decrease as purification proceeds.

The centrifuge lends itself to both continuous bypass and batch purification. It is adaptable to steam-turbine and engine, air- and refrigerating-compressor, and many other services. It will effectively remove water, inorganic constituents (insoluble sludge), dust, dirt, coarse carbon particles, etc., but it will not appreciably remove the so-called colloidal carbon particles, nor the organic-acid constituents (soluble sludge). In general, purified oil is dark in color, and if it is desired to restore the oil to its original color or approximately so, it is necessary to batch-treat or filter it through a chemical clay such as Fuller's earth, or a solution of sodium silicate in water (water glass).

The author is indebted to the DeLaval Separator Co., New York City; Goulds Pumps, Inc., Seneca Falls, N. Y.; Sharples Specialty Co., Philadelphia, Pa.; Westfalia Separator Co., Bloomfield, N. J., for assistance in preparation of this article.

CAPACITIES FOR DIESEL-ENGINE SERVICE

Brake Horsepower of Engine	Effective Capacities, Gallons per Hour		
	Viscosity, 200 S.S.U. or Less		Viscosity, 200–400 S.S.U.
	Continuous Bypass Method	Batch Method	Continuous Bypass Method
300	....	....	30
600	60	40	50
900	....	....	75
1,200	100	70	....
1,800	150	100	125
3,600	300	200	....

How to Compare Generated and Purchased Power Costs—I

By W. W. Gaylord

Consulting Engineer, New Haven, Conn.

Mr. Gaylord gives a number of examples which illustrate how power-cost comparisons should be made. A second article in June will give general principles

As a New Englander, William W. Gaylord is very matter of fact about himself. Very briefly and concisely he has told us these things—that he was born in Torrington, Conn., where he attended grammar and high school.

Then, that he was graduated from M.I.T. in 1906, and from then until 1923, worked with American Brass Co. For the next nine years, he was associated with Westcott & Mapes, Inc., Architects and Engineers, New Haven, Conn., as a mechanical engineer on design of industrial and central power stations. And, for the past five years, he has been a consulting engineer on heating and ventilating, power, industrial and electrical work.

As sidelines, he has made many studies of electric power rates in comparison with costs of generated power, has written articles for the technical press on power and related subjects, and teaches Heat Power Engineering at the Bridgeport Engineering Institute, Bridgeport, Conn., an evening school of college grade. He is a Mason, an A.S.M.E. member, and admits membership in the Sons of the American Revolution.

POWER and plant-service costs, always important factors, have lately put before many plant engineers the job of presenting data on the operating cost of their power plant for comparison with estimates submitted by a utility. Effect of purchased power on all other plant services must be considered as well as power costs alone. This means the engineer must assemble plant service costs, and also these same costs if power were purchased, before he can make a real comparison. A few examples will illustrate the procedure and show why all service costs should be considered and not just power alone.

The engineer of a small metal-working plant is called in by the general manager and given a report submitted by a power company which shows how an annual saving of $3,177 may be made by shutting down the generating plant at the factory and purchasing all power. He is asked to check this report and state whether he believes this saving can be made.

Procedure

His procedure in making a comparison should follow these general lines: First, he will list present equipment, and then the services it must supply. These services will undoubtedly include more than power, and will have a large effect on the final result, as total plant-service costs are of principal interest. He will next consider what records are available from which present costs can be determined and compared with the estimates given in the power company's report. Finally, he will tabulate these costs to show a true comparison by combining the estimate of power costs with other plant-service costs when the generator is not in operation.

His present plant consists of one 2,400-sq.ft., h.r.t. boiler, hand-fired, which supplies steam for a 200-kva. engine-driven generator, and also for process work. Steam pressure is 120 lb. per sq.in., and the engine is a simple 4-valve, non-condensing type. Exhaust steam is used to supply steam for building heating when required, and the balance wasted.

The heating system has about 11,000 sq.ft. of equivalent direct radiation, and the factory is located where some heating is required for 7 mo. in the year. Process steam at 50-lb. pressure is required the year round with an average demand of about 600 lb. per hr. Maximum demand may run as high as 1,500 lb. per hr. for an hour or more each morning. Boiler and engine are operated by the same man, and as the boiler must be used all the time to supply process steam, the same number of men would be required if power were purchased.

Records on coal used per year and kilowatt hours generated have been kept, but no division of costs between power and steam for process and heating is available. There is also a breakdown service connection from the power company of 50 kw. capacity. Records show that 200,000 kw.hr. were consumed annually of which 6,600 kw.hr. was furnished under the breakdown service, and the rest generated. 650 tons of coal were used.

The power company used an energy-charge rate with no demand charge, and their estimate of the cost of purchased and generated power given in their report was:

Purchased Power—Annual Cost

1,200 kw.-hr. at 5.0c.		$ 60.00
4,800 kw.-hr. at 4.5c.		216.00
12,000 kw.-hr. at 3.85c.		462.00
42,000 kw.-hr. at 2.90c.		1,218.00
120,000 kw.-hr. at 1.55c.		1,860.00
20,000 kw.-hr. at 1.28c.		256.00
200,000	Total	$4,072.00

Generated Power

Fuel 650 tons of coal at $5.85	$3,802.50
Water	200.00
Oil and supplies	100.00
Boiler and engine maintenance	300.00
Interest and depreciation 10% on $25,000	2,500.00
Break down power connection	300.00
Labor—$40.00 per week	2,080.00
Superintendence and overhead	500.00
Total power, heating and process steam costs	$9,782.50

Credit for Heating and Process Steam

Fuel to heat buildings 200 tons	$1,287.00
Fuel for process steam 90 tons	526.50
Water for heat and process steam	50.00
Decrease in labor costs	520.00
Engine maintenance	100.00
Engine oil and supplies	50.00
Total credit	$2,533.50
Net cost generated power	$7,249.00
Savings by purchased power	$3,177.00

These figures looked convincing, but the engineer, of the opinion that they did not show the whole picture, asked a consultant to prepare a complete comparison. It was shown that the above method of comparing power costs failed to take into consideration some important points, and so did not give a true picture, even though all of the figures used were essentially correct. It failed to show a comparison of the total service costs which should include power, building heating and process steam. That purchased power might actually increase the total service costs is shown by the analysis below. A major item in the Utility's analysis is interest and depreciation on the capital cost of the generating plant. This, which in many cases is a bookkeeping charge rather than an out-of-pocket expense, will not be changed by shutting down the generator as it will be impossible to dispose of this equipment so as to recover any considerable part of its original cost.

The actual comparison, then, had to be between total power, heating and process steam costs as given above for generated power and total power, heating and process steam costs for purchased power given below.

Purchased power 200,000 kw.-hr.	$ 4,072.00
Fuel for building heating 240 tons of coal	1,426.00
Fuel for process steam 105 tons of coal	624.25
Water	50.00
Supplies	50.00
Boiler maintenance	200.00
Interest and depreciation	2,500.00
Superintendence and overhead	400.00
Labor—$30 per week	1,560.00
Total	$10,882.25

This showed that, when total service costs are considered, there would have been an actual loss of $1,099.75 by purchasing power instead of a saving of $3,177.

Another case, introducing several additional conditions, showed a different result. A factory which makes a wide line of specialties, with some departments operating more than one shift per day, is located where power is bought on a demand-and-energy rate, which makes large reductions for high load factor.

The plant consists of three 1,500-sq.ft. boilers operated at 120 lb. gage pressure and a tandem-compound condensing Corliss engine belted to a 150-kva. generator. Electric load here averages 160 kw. during the day shift, 90 kw. during the second shift, and from 20 to 80 kw. during the third shift, depending on departments operating. There is a 24-hr. demand for process steam varying from 3,500 lb. per hr. during the day shift, to an average of 1,500 lb. per hr. during the third shift. A large part of this process steam is used at boiler pressure and the balance at about 40 lb. The engine is operated from 7 a.m. to 6 p.m., somewhat more than the day shift alone. Balance of the power is purchased. Steam for building heating is bled from the receiver between high- and low-pressure cylinders when the engine is running.

To Save $1,000 A Year

Here, the power company stated that the purchase of all power would save about $1,000 per year, based on an estimate giving only partial details. There were no complete records of power or service costs, but records of coal used and some steam-flow meter records for process steam were available. There was a reasonably accurate record of power generated, taken from a watt-hour meter on the switchboard, and, of course, the power company's billings showed power purchased previously.

The type of rate in effect makes the purchase of a part of the power required rather expensive, as the following analysis for a typical month will show. A total of 46,500 kw.hr. was used, of which 28,380 kw.hr. were generated and 18,120 kw.hr. purchased. The demand meter on the purchased power showed 121 kw. The monthly bill then was:

Demand

15 kw. at $2.80	$ 42.00
35 kw. at 2.00	70.00
71 kw. at 1.50	106.50
Total demand charge for 121 kw.	$218.50

Energy Charge

1,500 kw.-hr. at 2.8c.	$ 42.00
8,500 kw.-hr. at 1.5c.	127.50
8,120 kw.-hr. at 1.1c.	89.32
Total energy charge	$258.82
Total charge	$477.32

This is at the rate of 2.63 cents per kw.hr.

If all power had been purchased the billing would have been:

Demand

15 kw. at $2.80	$ 42.00
35 kw. at 2.00	70.00
136 kw. at 1.50	204.00
Total demand charge for 186 kw.	$316.00

Energy Charge

1,500 kw.-hr. at 2.8c.	$ 42.00
8,500 kw.-hr. at 1.5c.	127.50
36,500 kw.-hr. at 1.1c.	401.50
Total energy charge	$571.00
Total charges	$887.00

This is at 1.91 per kw.hr. for the total, or at 1.45 cents per kw.hr. for the part now generated. The power company estimated the average coal rate of the engine generator as 3.8 lb. per kw.hr., or a

fuel cost of 1.04 cents per kw.hr., the engineer's labor as 0.3 cents per kw.hr. and fixed charges and maintenance as 0.44 cents per kw.hr., making a total generated power cost of 1.74, or a saving of 0.29 per kw.hr. With an annual generation of 325,000 kw.hr., this showed a saving of $943.00.

Here again, the only way to get a true comparison of power costs is to show the effect of purchasing power on the complete power, heating and process steam costs as given by the analysis below:

Annual Cost for Power, Heat and Process Steam Generator Operated 11 Hr. per Day

Fuel, 2,500 tons of coal at $6.00	$15,000.00
Supplies, oil, etc.	650.00
Boiler and engine maintenance	350.00
Interest and depreciation (10% on $35,000)	3,500.00
Labor—1 engineer, 3 firemen, 1 coal passer	6,240.00
Superintendence and overhead	600.00
Purchased power 205,560 kw.-hr.	5,460.00
Total	$31,800.00

All Power Purchased

Fuel 1,907 tons of coal at $6.00	$11,442.00
Supplies	230.00
Boiler maintenance	200.00
Interest and depreciation	3,500.00
Labor—3 firemen, coal passer 6 months	4,200.00
Superintendence and overhead	500.00
Purchased power 530,640 kw.-hr.	10,285.00
Total	$30,357.00

This shows a saving of over $1,400 by purchasing power, even though the generating plant is slightly more efficient than at first considered, and the purchased power rate is higher for the same power used. Thus, it is evident that factors other than the actual comparative costs of a kilowatt hour on the switchboard are deciding factors. In this case, it is the lower rate for purchased power due to the higher load that makes purchased power show a saving.

A Third Example

A third case brings out another set of conditions by which it is sometimes possible to combine purchased and generated power and thus reduce service costs. This plant makes a varied line of metal products and novelties, and has a year round demand for process steam and a large demand for heating steam. Equipment consists of two 900-sq.ft. and one 2,000-sq.ft. sectional-header, water-tube boilers for 125 lb. operating pressure, and a 12 and 24x36 in. compound, non-condensing Corliss engine belted to a 200 kva. alternator. Average power load is about 90 kw., and there is a lighting load of about 20 kw. when all lights are required. Maximum loads of 145 kw. for half an hour have been recorded.

Process steam load averages about 1,000 lb. per hr., and when the engine is running, this is bled from the receiver between the engine cylinders. The factory has about 100,000 sq.ft. of floor space, and as women are employed in most departments, heating requirements are relatively high; nearly all exhaust steam is used during winter months. Estimates based on average loads and hours of operation indicated that 180 tons of coal would be required to produce process steam, and 500 tons for building heating if no power were generated; while 1,155 tons had been used during the last year of operation when 248,000 kw.hr. were generated and 39,100 were purchased.

The engine was used to generate all current for power and light from 7:00 a.m. to 5:00 p.m.; the rest of the time current was purchased, except when the whole factory was run overtime, in which case the engine ran also. Records showed that the engine was run about 2,900 hr. the previous year. Certain departments were running more hours, and some equipment was run all night, but power was purchased for these. Prevailing electric rate was of the energy-only type, and current was purchased for machines running overtime and all night, so that no standby or minimum charges had to be paid, even if all power were purchased five months in the year.

The power company submitted an estimate showing an annual saving of $1,650.00 by buying all power. This was based on replacing 240,000 kw.hr. of generated power with purchased power as follows:

Annual Cost of Purchased Power

240,000 kw.-hr. at 1.8c. per kw.-hr. (Average price)	$4,320.00

Annual Cost of Generated Power

240,000 kw.-hr. at 3.0c. per kw.-hr. (This based on fuel 1.7c., labor .5c., and fixed charges .8c.)	7,200.00
Credit exhaust steam to heating system equivalent to 200 tons at $6.15	1,230.00
Net cost of generated power	$5,970.00

This at first appeared convincing, but it was noticed that added cost of purchase light had been omitted, implying a reduction of fixed charges on equipment that could not be realized. To get a check and find what savings, if any, could be expected, three estimates of annual costs were made:

1. Engine Operated all Year for Main Power Supply

Fuel 1,155 tons of coal at $6.15 per ton	$ 7,103.25
Labor engineer $1,812.00 (40% charged to power plant and 60% mfg. plant maintenance)	725.00
firemen (day)	1,079.00
firemen (evening) } Part time, also act	462.60
firemen (night) } as watchmen	288.15
Maintenance (average year)	600.00
Supplies	400.00
Purchased power 31,000 kw.-hr.	1,150.00
Purchased light 8,000 kw.-hr.	400.00
	$12,208.00

2. Engine Operated Oct. 1 to May 1 for Main Power Supply. All Power Purchased May 1 to Oct. 1

Fuel 880 tons of coal at $6.15	5,412.00
Labor engineer $1,812. (30% charged to power plant)	544.00
firemen (day)	1,079.00
firemen (evening $1,542) } Part time only	
firemen (night $962) } charge to power	1,729.75
Maintenance	500.00
Supplies	300.00
Purchased power 132,500 kw.-hr.	2,680.00
Purchased light 13,500 kw.-hr.	620.00
Total	$11,785.75

3. All Power and Light Purchased

Boilers Operated for Process Steam and Heating Only	
Fuel 680 tons of coal at $6.15	4,182.00
Labor engineer $1,812. at 20%	362.00
3 firemen; part time	1,729.75
Maintenance	300.00
Supplies	150.00
Purchased power 270,000 kw.-hr.	4,968.00
Purchased light 20,500 kw.-hr.	878.00
Total	$12,569.75

This showed that purchasing all power was slightly more expensive than generating all power, while generating power during the heating season and purchasing power during the non-heating season showed a saving over either.

1,500-Lb. Top for Welsh Plant

Powell Duffryn Co.'s coal mine in Wales goes ultra-modern with new 220,000-lb. per hr. high-pressure steaming capacity. Topping turbine of 5,500 kw. exhausts to existing turbines aggregating 51,500 kw.

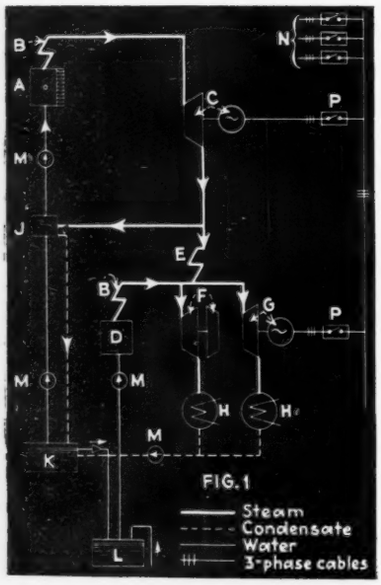


FIG. 1

Fig. 1—PLANT HOOKUP. A. 2 monotube boilers (pulverized-coal fired) with air preheater. Normal rating 110,000 lb. per hr. (each) at 1550 lb. gage. B. Superheater for 770 deg. at 1,550 lb. C. Back-pressure turbine (1,420 lb. to 355 lb.) driving 6,500 kw., 3-phase generator. D. 10 remaining water-tube boilers, each 35,000 lb. per hr. at 355 lb. pressure and 750 deg. E. Intermediate superheater. F. 3 turbine air compressors of 5,000 kw., including standby. G. 3 turbine generators, 2 of 12,000 kw., 1 of 6,000 kw. H. Surface condenser. J. Feedwater heaters for 355 F. K. Feedwater tank. L. Makeup water tank. M. Condensate and feed pumps. N. Power station (33,100 kw.) working in parallel. P. Main switch

Fig. 2—Two new single-tube boilers (normal capacity, 110,000 lb. per hr. each) furnish steam at 1550 lb. and 770 deg. F.

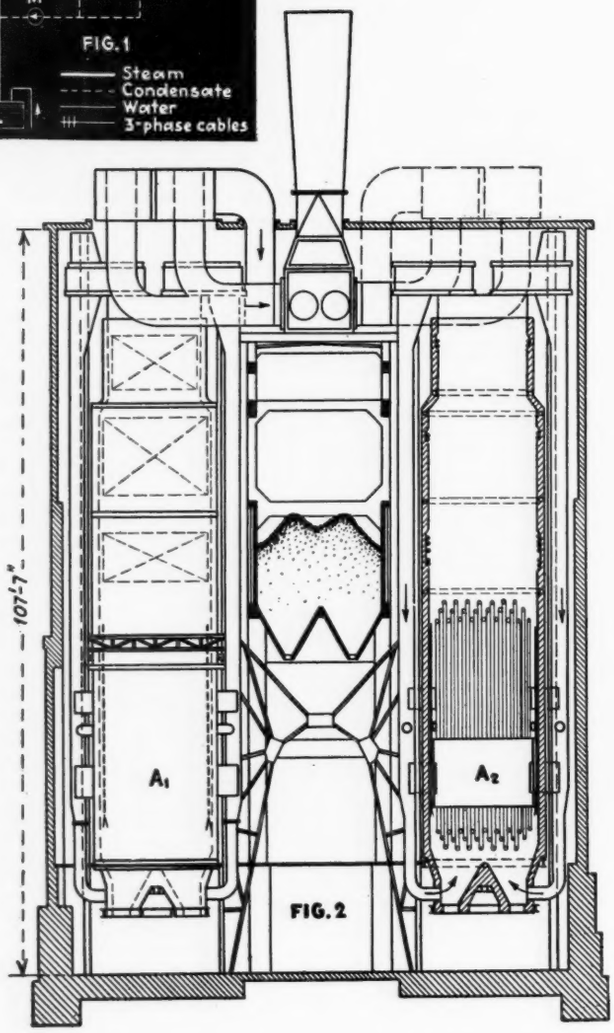


FIG. 2

NO MINE-OWNED power plant in America approaches in size the private central station of Powell Duffryn Co., a British colliery in Bargoed, Wales. Since 1929, its generating capacity has stood at 51,500 kw., the output supplying the company's coal mines and allied enterprises. Twelve 35,000-lb. per hr. B&W boilers supply steam at 355 lb. gage and 750 deg. F. Normal steam load is 220,000 lb. per hr.; maximum is 260,000. The 51,500-kw. station rating includes not only the generators, but also the kw. equivalent of the turbine-driven air compressors.

This modern and very large industrial plant will shortly become ultra-modern with the installation of a high-pressure "top." Sulzer Bros. (Winterthur), Switzerland, have been given the order for two monotube steam generators, each with a normal rated hourly capacity of 110,000 lb. of steam at 1,500 lb. and 770 deg. Actually, each of these boilers will be able to carry a maximum continuous load of 130,000 lb., and short peaks of 150,000 lb.

Heating surface of the monotube boilers consists of a single tube several thousand feet long, through which water is pumped at high velocity. Steam will be delivered to the high-pressure turbine (5,500-kw. normal capacity and 6,500-kw. maximum), and will expand to 355 lb. gage. After reheating to 750 deg. F., it will pass to existing turbines, as shown in Fig. 1.

Adds 5,500 Kw.

This installation will add 5,500 to 6,500 kw. to the plant capacity without any increase in medium- or low-pressure equipment or in the amount of steam going to condenser. The new high-pressure topping turbine will be furnished by Brown-Boveri. Of the 12 existing boilers, only two will be moved to make space for the new single-tube generators. Since exhaust from the back-pressure turbine can heat feedwater to 355 deg., economizers could not be justified. Air preheaters, therefore, will be installed to give adequate cooling of flue gas and improve combustion.

Two of the existing 355-lb. pressure boilers will generally be kept on the line to supplement steam supply to the medium-pressure system, although the topping turbine will normally furnish enough exhaust. In case one of the two high-pressure steam generators should not be available, load on the other could be increased to about 150,000 lb. per hr., and additional steam required could be produced by other medium-pressure boilers brought into service.

Except for firing, regulation of the plant is entirely automatic. Firing is remote-controlled to conform with the service requirements of the moment, while quantity of water fed to generators and temperature is automatically regulated.

Because of the limited floor space, the monotube boilers will be vertical. Adoption of pulverized-coal firing also made this design necessary. Sulzer Bros. are general contractors for erection of the plant, including boilers, intermediate superheaters, pulverized-coal-firing equipment, air preheaters, feedwater heaters, fans and regulating devices.

High-Powered Horseradish

By R. H. Rogers

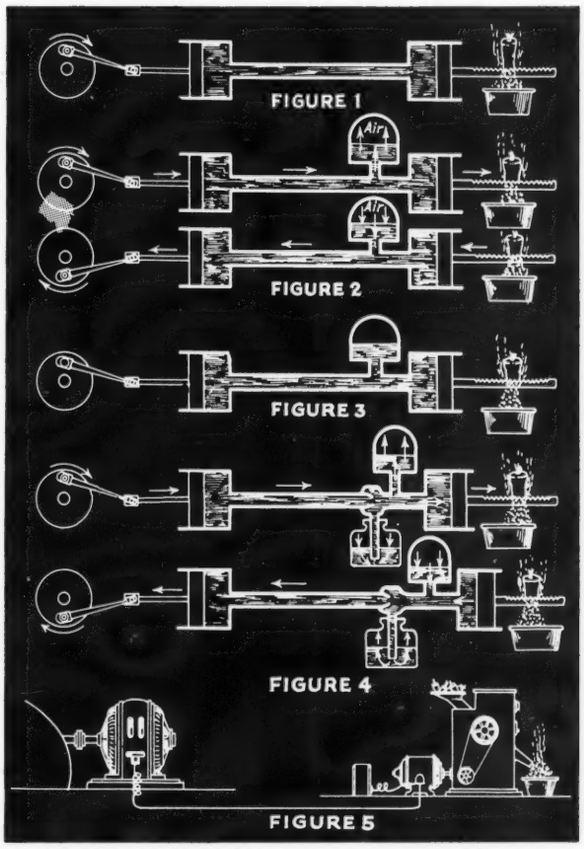
Industrial Dept., General Electric Co.

UNCLE EB raises horseradish, and grating it by hand got pretty tedious. He had an old waterwheel up by the dam where the mill was, but the grating job was done down back of the house by the root cellar. But Uncle Eb had a hankering for better things, so figuring that he could get the power from the wheel down to the grater through a water pipe, he hooked a piston and cylinder to the waterwheel and laid a pipe down to another cylinder and piston of the same size at the root cellar. When the piston at the dam worked back and forth, the other piston worked back and forth too and grated the horseradish. This is what he thought he had, Fig. 1.

The second cylinder came from an old steam pump and had an air dome on it to keep the water hammer from busting out somewhere. Well, the scheme worked pretty well, but Uncle Eb figured that the water pushing back and forth at the dam wasn't all showing up at the grater. Young Ebbie, Uncle Eb's boy, laid down his mouth organ a spell and allowed that there was water going into the dome with every pressure stroke, and coming back out on every suction stroke, Fig. 2.

Uncle Eb could see right away that, with all the extra water sloshing back and forth in and out, his power cylinder and the pipe should have been figured some bigger.

But, thunderation! It couldn't be changed now. And yet, with a howling big crop of horseradish coming along, Uncle Eb wanted to work his power plant at top notch. Young Ebbie, he figured that if there was some way to put water in, down by the grater, just when the dome was taking it out, then have the same gadget take it out again when the dome was discharging, why, then, the cylinder and pipe would never know about the extra water.



"Red" Puts in a Word

It appeared like there wasn't any way to put water in while the pressure was going up—that seemed contrary to nature. But young Ebbie told Red, when he came after the canned horseradish, what the trouble was, and Red remembered an old ejector that was in the cellar down to the store that they used before there was a good drain put in. Ebbie could see right away, when it was explained to him, that the ejector would do the trick. They finally got the old ejector connected in near the dome, and every time there was a rush of water to the dome, the ejector picked up water out of a can and shot it into the pipe. When the suction stroke came along, water came out of the dome and ran through the ejector back into the can, like in Fig. 4.

Uncle Eb was plumb tickled when he found that his mistake in figuring had been evened up, for now the full capacity of his power cylinder and pipe was grating horseradish, just what he had figured on having it do.

Now here is what really happened. Uncle Eb had connected an alternator to his waterwheel and put an induction motor on his grater, and connected them up with cable, figuring that he only had to take care of current for grating horseradish. However, the induction motor took current for magnetizing, but paid it back regularly. Nevertheless, it was there to be handled. Well, the alternator and cable got hotter than mustard, so Uncle Eb called the nearest office about a larger alternator and another string of cable. The fellow there told him it wouldn't be necessary because a thing called a capacitor would supply current when the motor field circuit wanted it, and would absorb it again when it came back from the field winding.

Well, the upshot was that Uncle Eb and Ebbie got a capacitor and connected it in close to the motor, Fig. 5. Now the alternator and cable are cool, even when the grater is working the motor up to capacity, and that was just what Uncle Ebenezer had been thinking about all the time—unity power factor.

New Heat-Transfer Units Simplify Air Conditioning

By Paul A. Scherer

Refrigeration Consultant, San Francisco, Calif.

A NEW TYPE of air conditioning system,* differing radically from conventional design, has been in successful operation for over two years at the large storage plant recently constructed by the Placerville Fruit Growers Association. General design specifications for the precooling and storage plant, handling one of the finest pear crops grown in California, were based on studies made at the University of California and on the experience of the Association's management in handling pear shipments. Final specifications called for capacity to precool 20,000 standard boxes of pears per day to a core temperature in the low thirties within the first 48 hr., thereafter reaching an equalized temperature of 31½ deg. at the end of 72 hr. Storage capacity for 230,400 such boxes, a minimum air temperature of 29 deg., and a precooled air volume of 3.750 c.f.m. per car of 720 standard pear boxes was required. This volume of air is far in excess of previous recommendations, and it was further specified that humidity in excess of 90% should be maintained.

The Placerville storage building is 5 stories high, with heavy structural-timber frame braced with steel panels and insulated with a 6-in. shell of shredded redwood bark without insulated interior subdivisions. Lower four floors of the building are devoted to fruit-storage and precooling rooms, and the fifth floor, or brine loft, contains a new type of brine-film surface, four main fans and the brine filter. Dimensions of the building are 137 ft. long, 106 ft. deep and 75 ft. high.

Plan of the fruit-storage floors is common to each of the lower four stories. Each floor is subdivided into ten rooms, five on each side of a central corridor. Each room holds eight cars of 720 boxes each.

At the ends of the rooms farthest from the central corridor and extending the full width and height of the building are two air-supply plenum spaces approximately 3 ft. wide which open to the brine loft. Conditioned air from the plenum chamber is supplied through a metal opening at ceiling height to each of the storage rooms. Suspended ceilings are hung in every room and slope from the air entrance and toward the room corridors. Set into the floor of each room are orifice exhaust openings and 4-position adjustment plates joined together in gang controls serving each car lot individually and adjusted from the conveyor aisle. This arrangement is shown in Figs. 1 and 3.

Return air from the storage rooms is drawn through the adjustable orifices into a duct formed between the floor and suspended ceiling of the room below and thence into the central corridor, which was made available as an air duct by using floor gratings. Return air moves upward to four 75,000-c.f.m., backward-curved, double-inlet fans on the 5th floor directly above the central corridor. At full load these fans circulate 280,000 c.f.m. of air at ⅝-in. static pressure, 90% relative humidity and 29-deg. dry bulb. Suction connections are arranged so that each fan draws air from opposite ends of the central corridor and discharges into a quarter segment of the fifth floor through distribution plates in front of the brine-film air-conditioning surfaces which enclose the fans in a hollow square divided by partitions into the four segments supplied by each fan. Air leaving the air-conditioning units may pass to either of the supply plenum chambers and flow into any room that may have its entrance damper open. It passes over the top of the fruit, travels vertically downward through chimneys formed by the stacked boxes of fruit and passes to the return-air corridor through the floor orifices.

Fig. 1—One of the fruit storage rooms showing an inlet at end of room and outlet orifices in the floor

In operation, the plant engineer simply maintains a ⅝-in. static pressure by cutting in the required number of fans for the actual load, and the storage operator independently sets the position of the orifice plates as the fruit is precooled. Entrance dampers serve as shut-offs for rooms not in use. Suitable controls close discharges of fans not in operation and provide for entrance of outside air when desired. Ordinarily, orifice gang plates are set in the wide-open position for the first 47 hr. of precooling, in a second position of about ⅓ volume for the next 24 hr. and then, should the car

*General design is broadly protected by patents granted and applied for.

be held in storage, set in the third or fourth position of under 1/15 volume.

The brine-film air-conditioning units have parallel vertical surfaces formed by weaving cotton fabric between upper and lower grids. The upper grid members are of an inverted T cross-section, Fig. 2, with the fabric running over the top of a central rib and across the two sides of the inverted T, from whence it is stretched downward to the lower grid composed of rods. At either end of each member of the upper grid, the T is closed to form a triangle. Chilled brine is introduced on both sides of the vertical rib in the space enclosed by the fabric. A surface-tension seal formed by the fabric holds the brine to a depth of $\frac{5}{8}$ in., causing it to percolate evenly downward through the fabric forming a film of flowing brine on each side of each sheet. Air is directed horizontally and parallel to these surfaces over 9 lineal feet of surface contact. Surface-friction eddies bring practically all air into

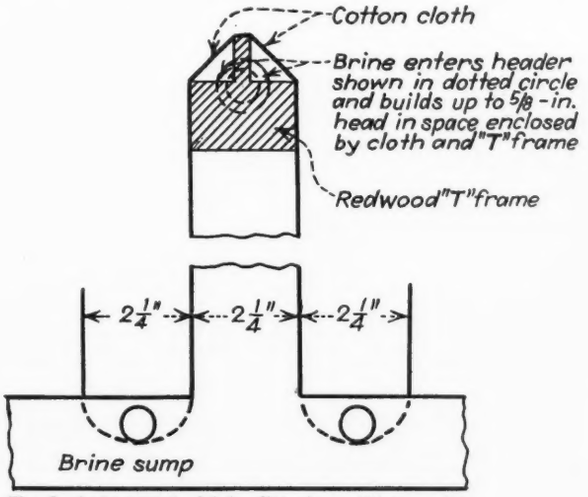

Cotton cloth
Brine enters header shown in dotted circle and builds up to 5/8-in. head in space enclosed by cloth and "T" frame
Redwood "T" frame
2 1/4"
2 1/4"
2 1/4"
Brine sump

Fig. 2—Arrangement of brine-film air conditioner. Air passes between cloth in direction vertical to the page

intimate contact with the flowing brine, permitting rapid heat transfer. Relative humidity is largely controlled by salinity of the brine. Since surface areas exposed are great, the total refrigeration load exercises but slight effect on humidity, thus with the Salinometer control alone, relative humidity of supply air is held uniform.

Brine is fed to the film surfaces through a simple distribution system with orifice control, maximum flow being 1,800 g.p.m. at approximately 29 deg. F. Brine film, flowing downward, enters a brine pan in which the lower frame of the unit is immersed. No free brine is introduced into the air stream and no carryover problems are involved.

Total brine-film surface is 168,000 sq.ft. With air velocities of 350 ft. per min., the air leaves within 1 to $1\frac{1}{2}$ deg. of the brine-leaving temperature.

Intimate surface contact of the air and brine film also results in efficient removal of dust particles and fungus spores. No spread of mold has been observed within the plant during the two seasons of operation at the high humidities required. Toxic gases are also removed from the conditioned air. For example, ethylene is first absorbed in the brine and then oxidized by chemicals within the brine. Control of the hydrogen-ion concentration of the brine governs carbon-dioxide concentration. In spite of the large volumes of CO_2 generated by the fruit, concentrations below atmospheric levels are maintained. Odors are also absorbed by the brine.

Brine leaving conditioners returns through open flumes to a brine tank. It is here filtered through a shallow sand filter of sufficient area to render it unnecessary to clean the filter during the operating season. Upon leaving the brine tank, it enters a closed system, passing through two shell-and-tube brine coolers and three brine pumps in a basement equipment room. It is then returned to a surge tank and weir on the fifth floor, from which it is distributed by gravity to the upper grids of the brine-film-surface supporting frames. The equipment room is insulated and provided with a float-controlled expansion coil which holds this room at a dewpoint lower than evaporator temperature, hence frost and condensate are not deposited on evaporator and pump surfaces. Cork insulation has not been applied to either evaporator or pumps.

Three Frick ammonia compressors providing 217

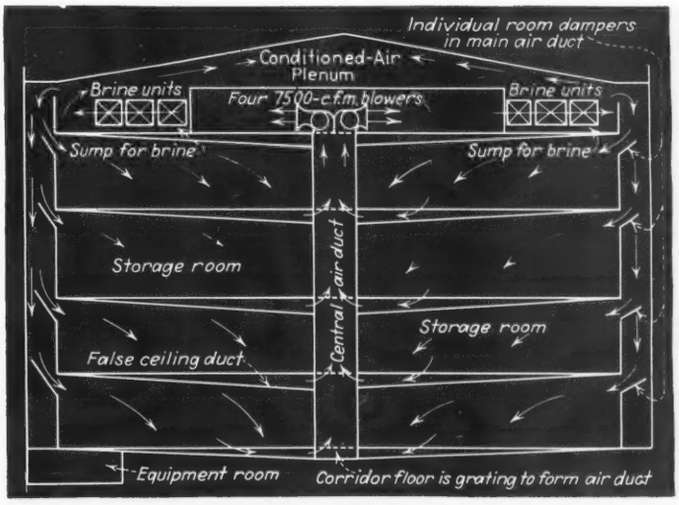


Fig. 3—Cross-section showing supply and exhaust ducts

tons of refrigeration are in a separate building constructed between the storage plant and an existing packing house. This building also houses a 50-ton ice tank and 5,000-ton ice storage. Variable clearance pockets on two compressors provide capacity control for small fluctuations in load. V-belt drives with flat driven pulleys make it possible to change compressor speeds by shifting pulleys, providing capacity control for larger variations.

Supply air is maintained at 29 deg. F., and the plant can receive 20,000 boxes of packed fruit every day without affecting this temperature. Thermometers are on the outlet-air ducts of each room. Temperature rise through the room determines the size of the floor opening to be used. If the room is full of fruit at 80 deg. F., the temperature difference will be 15 deg. for the first few hours, and at the end of 24 hr. it will be 3 to 4 deg., when the next size opening may be used. By this method, when the fruit is cooled, the smallest opening (2,500 cu.ft. per room) is used until the stored fruit is moved. At this rate of cooling, fruit in the center of the box load will cool to the low thirties within 55 hr.

Safe Harbor Welding Experience—II

By P. M. Hess

Station Superintendent,
Safe Harbor Water Power Corp.

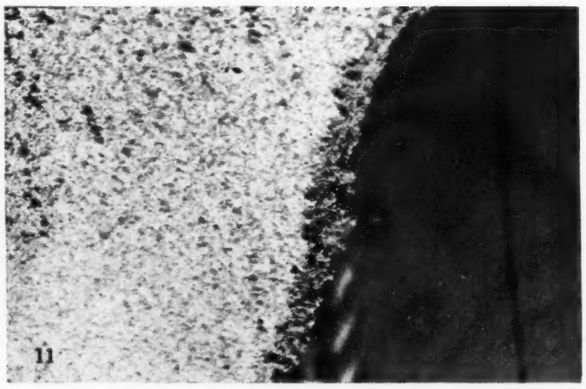
Preliminary studies, repair procedure and safety precautions taken on stainless-steel welding of pitted areas on four 42,500-hp. turbines were presented in March *Power*, page 138. This, the second article, outlines welding and grinding problems, tells how they were solved, and gives costs of the work

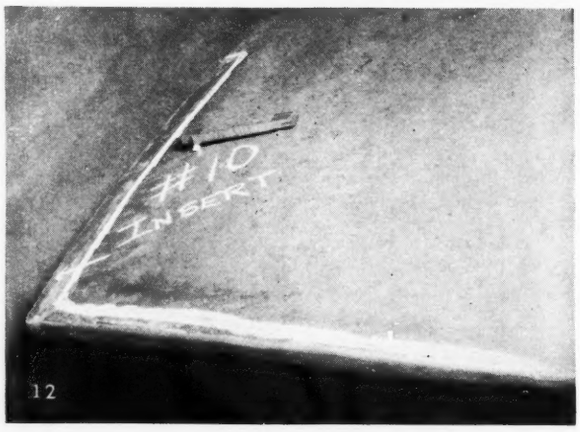
STAINLESS-STEEL welding of pitted areas of the Safe-Harbor turbines presented many problems which required extensive experimental work and study. For example, much work had to be done overhead and in tight places.

When stainless steel is applied by welding, temperature of the work must be maintained comparatively low, therefore it is usually necessary to stagger application zones. With $\frac{1}{8}$-in. rod, the largest we found satisfactory for overhead welding, heat generated distributed itself quite rapidly and did not warp the blade. We did not find it necessary to weld in zones. Average depth of stainless steel applied on overhead work ranged in the neighborhood of $\frac{1}{8}$ in. At first effort, we tried to fill the chipped areas completely with one coat. Grinding for finished surface showed, however, that a homogeneous weld could not be obtained. Consequently, all later welds were made in two layers, both running in the same direction because of the inconvenient welding position necessary to apply the second bead at right angles to the first. Some manufacturers advocate right-angle application of alternate layers, but on this job, running both layers in the same direction produced better work.

Since much of the severe pitting occurred on the blade periphery, Fig. 11, where working clearance is small, it was necessary to develop means for repairing these areas without removing the turbine runner from its setting. At first, preformed stainless inserts were purchased and welded into the pitted areas. This was accomplished with considerable difficulty due to difference in expansion between ordinary and stainless steel. By using a rod containing uranium, it was possible to make a satisfactory bond, after which the bonded section was covered with a stainless coating. Fig. 12 shows a typical insert. The horizontal work on Fig. 12 is a built-up section, not an insert. Fig. 13 shows the pitted horizontal or trailing edge before welding.

We found, on later jobs, that it was cheaper and quicker to build up the pitted periphery by welding in a manner shown in Fig. 15. Pitted parts are first burned out to solid metal with an acetylene torch, on an angle of approximately 45 deg. A strip of copper bus 0.25 in. thick, the required clearance, is inserted between the blade and throat ring and held in position by temporary supports. Stainless-steel rod is applied horizontally, starting at the bottom of the prepared section, and gradually built up to the original contour. The horizontal or flat portion is then ground smooth, no attempt being





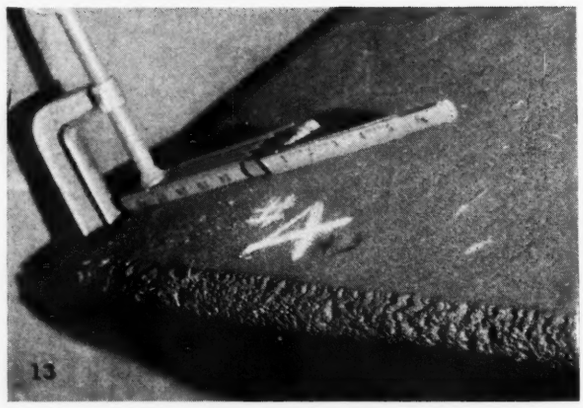


Fig. 11—Severe pitting on the periphery trailing edges of turbine blades. Fig. 12—Stainless-steel insert welded into pitted area at edge of blade. Fig. 13—Effects of cavitation on trailing edge of blade prior to welding

made to grind the surface adjacent to the copper. This work is flat welding, hence a $\frac{3}{16}$-in. rod is used for the main bulk. Near the copper strip, $\frac{1}{8}$-in. rod is used with a current higher than normal for this size wire, to make the flux coating more fluid, thereby obtaining a smoother surface against the copper, where grinding cannot be done.

After the pitted area is built to original shape, the copper strip can readily be knocked out with a small hammer. There is no tendency for the stainless steel to bond to the copper. It was found recently that straight 18% chrome rod with a carbon content not exceeding 0.07% produces a much better finished surface against the copper than does the 18% chrome and 8% nickel, hence this has been standardized for this type of work.

Grinding Problems

After two layers of welded metal are applied on the surfaces and the edges are filled, grinding is started. Grinders purchased initially were comparatively light, since it was believed that the grinding tools would have to be supported by the operators and effort was made to eliminate fatigue. Later it was found, after developing various adjustable grinding-tool supports, that the heaviest grinder available was none too powerful for the job. (See Figs. 6 and 8, March *Power*). Heavy-duty grinders have reduced grinding costs nearly 50%, in addition to cutting the grinding time almost in half.

Reduction in grinding time and cost is not only the result of using heavier grinders, but of the type of wheels used. Several grinding-wheel manufacturers supplied samples of various grades of wheels which were tried on the actual work. The wheels adopted are made up of comparatively coarse grained material, rubber bonded, and are considered soft wheels. Soft wheels with coarse grains remove more material with a correspondingly greater wear in grinding wheels. Cost of grinding wheels, however, is a very small part of total cost; therefore the fastest-cutting wheels are cheapest. Hard fine-grade grinding wheels were tried, but the pores in the wheel filled with metal, caused burning and ceased to grind after the pores filled. A wheel must discard the removed metal to be effective.

It was difficult to grind welded portions close to the throat ring, as a special-shape wheel was required. Since a soft wheel is necessary to grind stainless weld, its shape soon became altered and no longer effective. Conventional-type horizontal and vertical grinders did not permit working on the outer edge of the blade because of throat-ring interference with either the nut, spindle, or body of the grinder. A grinder having the wheel driven by bevel gears was purchased and solved this problem.

This grinder is a standard tool used for grinding marble or granite, having a water-cooling connection attached, not necessary in this case. A standard countersunk wheel can be operated either vertically or horizontally, and the small head encasing the gears permits almost any desired angle of operation necessary to contact the work. Wheel shape is not altered materially during grinding, and the ability to continually change the working angle without interference permits almost a maximum use of the wheel. (See Fig. 8, A, B & C March *Power*).

Scope of Work

As mentioned previously, the first case of pitting occurred on the leading edge of the blades both at top and bottom, and was easily corrected by reshaping. The first major pitting occurred on the under side of the trailing section, extending over an area of approximately 4 sq.ft. on each blade. In addition to this large area, numerous scattered areas appeared on each blade, having no particular definite location. These scattered areas are attributed to uneven finish and had the initial finish been better, no pitting would have occurred at most of them, especially the areas nearer the hub section where lower velocities are encountered.

In general, sections subject to pitting, even though the original finish was perfect, have assumed a more or less definite shape, somewhat as shown on Fig.

Fig. 14 — Approximately the blade area over which pitting occurred

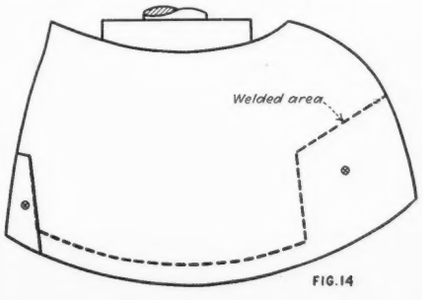


FIG. 14

Fig. 15—How pitted peripheries of the blades next to the throat ring were built up by welding

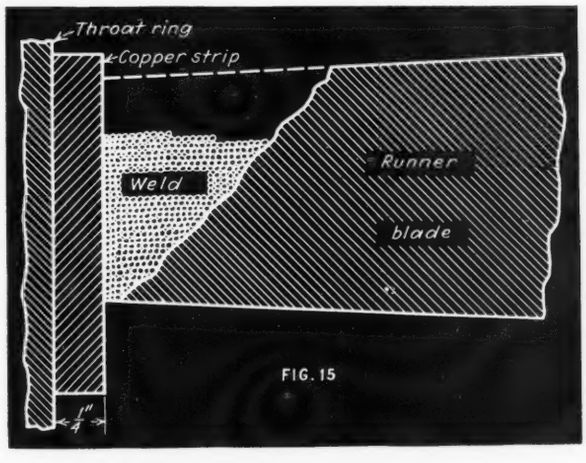


FIG. 15

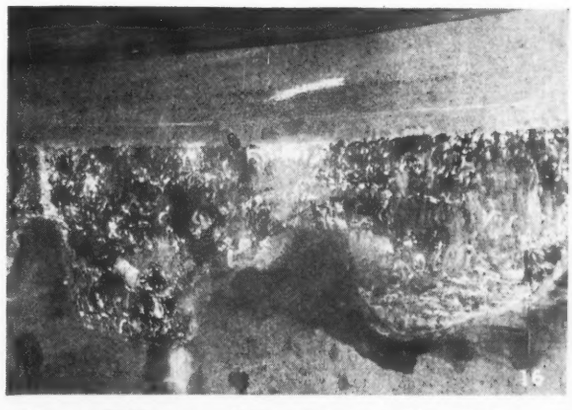


Fig. 16—Welded and polished repairs on turbine throat ring at top of draft tube

14, which represents the areas pre-welded on the turbine installed in 1934. Realizing the excessive repair work necessitated by uneven finish, the company had the blades of this runner machine finished in addition to pre-welded. This decision was a wise one, for after more than two years of operation, no welding has been required and no appreciable pitting has occurred outside of the pre-welded areas.

One manufacturer finished the trailing edge of the blades more or less semi-elliptical or streamlined, while the other decided upon a sharp rectangular section. The former shape, at first considered the better, was subjected to severe pitting, whereas the latter showed very little. Fig. 13 shows pitting on the elliptical finish of the blade edge. The belief is that voids exist beyond the trailing edge of the rectangular sectional blade, but the action occurs away from the metal, resulting in practically no pitting. For repair work, all trailing edges are now made square.

Throat-Ring Repairs

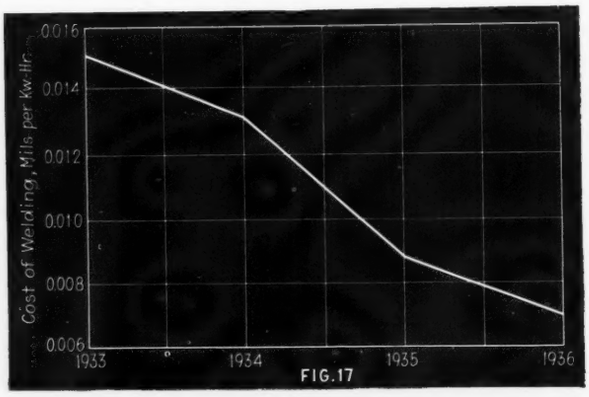
Early in 1934, it became evident that early repair work would be necessary on the turbine throat ring in the vicinity of the runner. Almost directly below each wicket gate, in line with flow of water, pitting was quite active in an area of about 1 sq.ft. This area gradually spread so that by 1935 it was about 50% larger and of a sufficient amount to join the adjacent area, producing a scalloped formation. Fig. 16 shows welded and polished repairs. Repair work at this location is comparatively simple and can be carried out for approximately half the cost and in 75% of the time required for the same area on the blades.

Costs

To one not closely associated with the scope of pitting repairs required on Kaplain turbines, the first impression obtained might not be very optimistic and it is hoped that the following cost figures will help to remove this doubt. Referring to Figs. 17 and 18, it will be seen that the trend both in cost and in amount of repairs required from year to year is gradually falling. For instance, in 1933 total cost of welding amounted to only 0.015 mils per kw. hr. generated, and for 1936, to 0.007 mils with an average cost to date of 0.0102 mils per kw. hr. generated. In other words, average cost to date amounts to $10.20 for each million kilowatt-hours generated. This cost is broken down into cost per cu. in. for labor, material and total both for the entire period and for 1936, Tables I to III. Labor-cost increase is due to increase in wages, whereas the material cost reduction is the result of experience and selection of materials. The item miscellaneous in Table III includes sharpening tools, setting up welding machines, fitting air lines, painting, safety equipment, illumination, unwatering and rewatering pit, etc.

With completion of the 1937 low-flow welding program, which is estimated to be about 1,000 cu. in. on blades and 600 cu. in. on throat ring, amounting to approximately $4.00 per million kw. hr. generated, the more vulnerable areas will be completely coated with stainless steel. Thereafter, only minor attention will be required from time to time, reducing pitting repairs to a negligble item.

Although this work has been successfully carried out, it should be understood that applying stainless steel to pitted areas is not a cure-all for the evil effects of cavitation. It does, however, have high resistance to these attacks and resists corrosion, which in itself accelerates pitting.



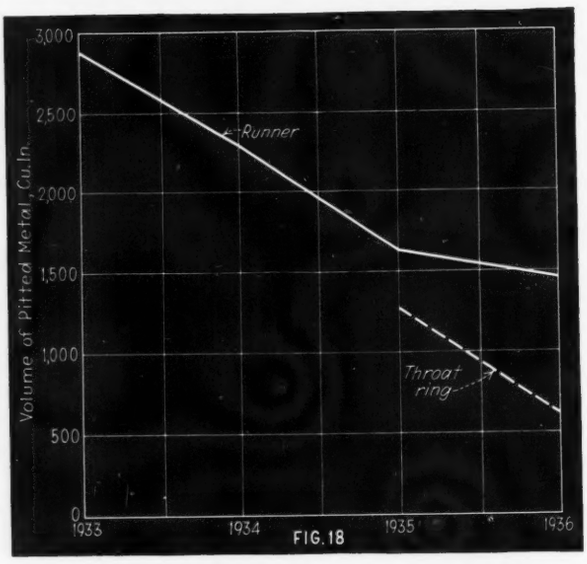


Fig. 17—How cost of welding has decreased. Fig. 18—Volume of pitted metal has gradually decreased since welding was started in 1933

TABLE I—*Costs for Years 1933 to 1936 Inclusive**

		Blades	*Throat Ring*	*Total*
Cubic Inch		8,191	1,843	10,034
Cost Per Cu. In.	Labor	$1.73	$0.96	$1.59
	Material	$1.27	$0.62	$1.15
	Total	$3.00	$1.58	$2.74

TABLE II—*Welding Costs for Year 1936**

		Blades	*Throat Ring*	*Total*
Cubic Inch		1,435	600	2,035
Cost Per Cu. In.	Labor	$1.84	$0.72	$1.50
	Material	$0.83	$0.57	$0.76
	Total	$2.67	$1.29	$2.26

*All figures based on finished work

TABLE III—*Welding Labor Distribution, Man Hours*

Welding	Chipping	Grinding	Scaffold	Misc.	Total
36.0%	9.5%	34.0%	9.0%	11.5%	100%

Let Your Tanks Rest in Peace

By James O. G. Gibbons

Consulting Engineer

WHEN TANKS for oil or other liquids are buried in earth subject to high-water conditions, it is necessary to load or anchor them to prevent them from floating. This is too often done in a more or less haphazard manner, trusting to luck that the anchorage will prove to be adequate.

A quite common method is to anchor the tank to a concrete foundation with steel cables, but even when the anchorage has been properly designed in the office, the cables are too often not installed so that lashings are tight and each cable takes its full share of the load.

The following method of dealing with the problem has proved very satisfactory. Even if it may at first sight appear to be somewhat expensive, it often turns out to be economical in the end.

We will assume that no appreciable constituent of the earth is soluble in water, and that the excavation can be kept sufficiently dry to let the concrete set. Let us take an extreme case where the tank is buried 2 ft. below ground level, and water may rise to this level, completely submerging the tank.

We will assume that we have a 20,000-gal. tank, 10 ft. in diam. and 34 ft. long, weighing about 14,000 lb. empty. We are going to place a reinforced-concrete mat under this tank, 12 ft. wide and 35 ft. long, tentatively 6 in. thick.

We shall then get the following conditions: Excavation $12 \times 35 = 420$ sq. ft., $12\frac{1}{2}$ ft. deep, making 5,250 cu. ft. High water in excavation $10\frac{1}{2}$ ft. deep = 4,410 cu. ft., or about 275,000 lb. of water, which must be displaced by an equal weight to avoid floating.

The capacity of the tank is 20,000 gal., or about 2,670 cu. ft. leaving 5250—2670 or 2580 cu. ft. into which we must put 275,000 lb. of material to replace the water.

As the tank weighs 14,000 lb., we must put 261,000 lb. in the hole, but if we used earth only weighing 90 lb. per cu.ft. we should get 2580x90 lbs, or 232,200, which is 28,800 lb. short.

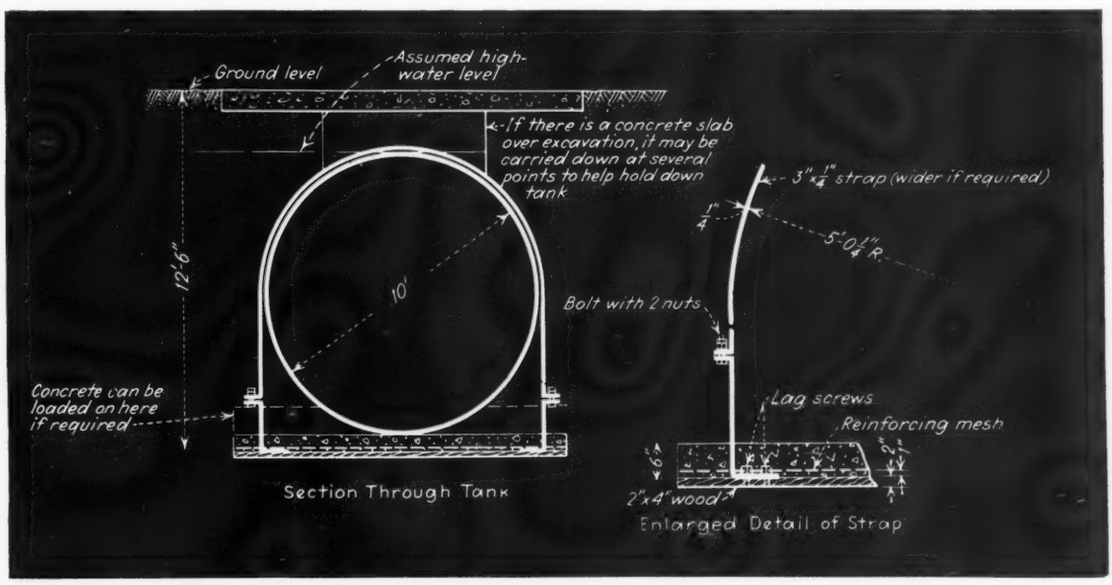
If we assume that concrete weighs 140 lb. per cu. ft. we shall gain 50 lb. per cu. ft. for every cubic foot of earth which we displace, so that we should need 576 cu. ft. of concrete, and that is the real answer to our problem as far as the total weight of concrete is concerned.

We can make the concrete slab under the tank 6-in. thick, which will give us 210 cu. ft. which is 366 cu.ft. short, so we can load more concrete onto the slab, or better still load some onto the top of the tank, thus relieving the upward thrust on the tank straps. Very often a concrete slab is required over the excavation, in which case it can be carried down so that its weight rests on the tank.

The illustration shows a very satisfactory method of strapping down the tank. The strength and number of straps can be easily figured from the fact that the upward thrust when the tank is empty and completely submerged will be equal to the weight of the water displaced, less the weight of the empty tank and any concrete or enclosed earth which may be placed above it. If the tank cannot be completely submerged, calculations can be modified accordingly.

When possible, I have used $3 \times \frac{1}{4}$-in. straps, as shown, and strap feet screwed or spiked to wood sleepers so that they will stay in place until the concrete has set. Reinforcing mesh is laid in the slab as shown, with strap feet hooked under it to help distribute thrust.

The great advantage of the above method of figuring is that we have definitely provided for the worst possible conditions, and if we can reduce factor of safety we know exactly what we are doing. If other methods of figuring are used, it is very easy to make a mistake due to the fact that the effective weight of a great deal of our loading material must be figured in water and not in air.



Free-Wheeling Applied to Power Drives

For certain power applications, it is desirable to have the power unit free to slow down independent of load, a feature possible with free-wheeling clutches

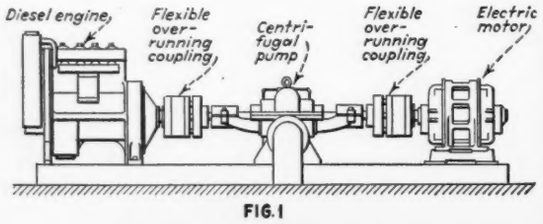


FIG. 1

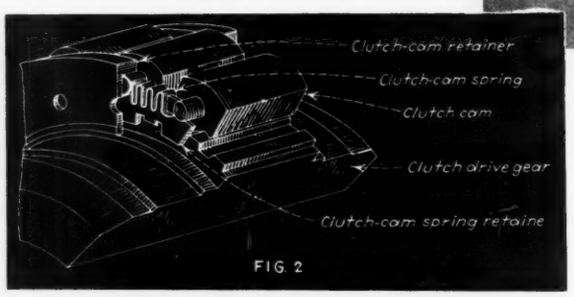


FIG. 2

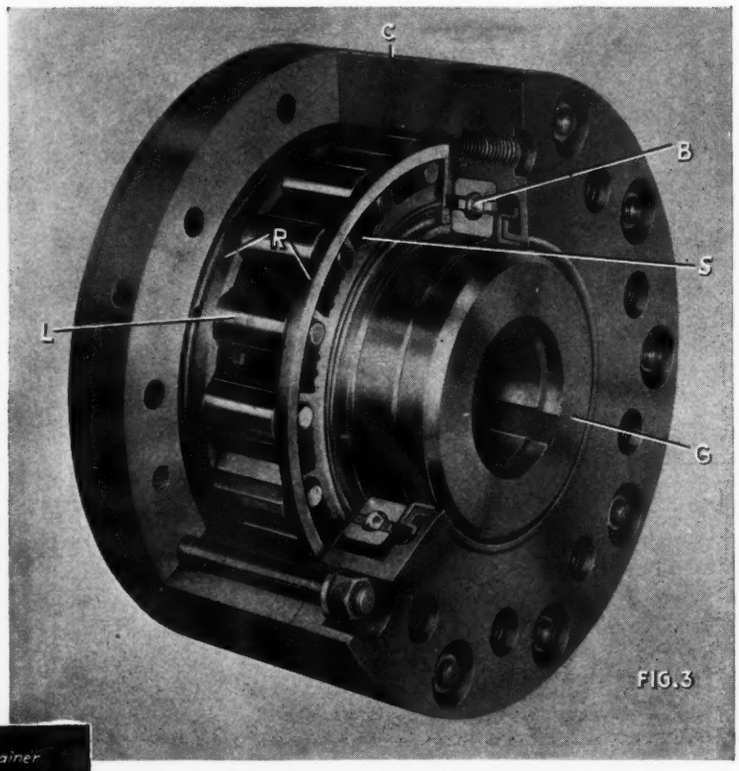


FIG. 3

Fig. 1—Over-running clutch of Fig. 4 applied to dual drive on a centrifugal pump. Fig. 2—A section of the free-wheeling clutch of Fig. 3. Fig. 3—Cylindrical cams form the clutching member in this type of free-wheeling clutch

FREE-WHEELING or over-running clutches have come into quite general use on dual drives from two power sources, 2-speed drives and similar applications. With this device, as long as the power unit drives the load, the clutch remains engaged. If for any reason the driver tends to run slower than the load, or the load increases its speed above that of the power unit, the clutch releases.

For example, a 2-speed motor drives a fan through an ordinary flexible coupling. If the fan is being driven by the high-speed winding and is switched to slow speed, the latter will create a powerful braking action which may damage the fan rotor. This difficulty can be eliminated by connecting the motor to the fan with a free-wheeling clutch. When switching from high to low speed, the fan is free to rotate until it slows down to the motor speed, when the clutch will again connect the two together. The same conditions apply when a slow-speed and a high-speed motor are used to drive a load. A free-wheeling clutch between the slow-speed motor and its load allows switching at will from one motor to the other without danger to either motor or load. If two free-wheeling clutches are used, one between each motor and its load, either motor may be automatically disconnected by simply disconnecting it from the power source. On dual drives, if each power unit is connected to the load with an over-running clutch, they may be started and stopped at will without stopping the load, and when a drive is stopped it will be automatically disconnected from the load. Many other drives exist where this equipment has an economic place in mechanical power-transmission applications.

Fig. 3, showing the construction of a clutch of this type, comprises three major elements: a driver, a driven member and locking or clutching members. An inner gear member *G* and the outer cylindrical member *C* may be either the driving or the driven member, but it is preferred to have the outer member running during free-wheeling operation. Locking or clutching members are cylindrical cams *L*, with surfaces generated to produce a rolling and wedging action between driving and driven members. On the inner surface of the cams are teeth that register with gear teeth cut in the outer surface of the clutch inner member, Fig. 2. These gear teeth serve to space the cams, to keep them in alignment,

and to react the pressure of the individual springs *S* that rotate the cams and hold them at all times in contact with the outer clutch member. By virtue of the two cam-retainer rings *R*, shouldered to support the extension pilot at each end of the cams, centrifugal force of the cams is reacted in a manner that provides for smooth operation of the clutch. The outer ring member *C* is supported at each end on the inner member by a ball bearing *B*, which allows one member to ride freely on the other during free-wheeling periods. Each end of the clutch mechanism is inclosed with practically frictionless oil seals so that all moving parts operate in oil, which thoroughly lubricates and protects them.

Operation of the clutch is simple. During free-wheeling, cams are always lightly in contact with the outer drum. If the driving member tends to run faster than the driven member, friction on the cams rotates them slightly and wedges them between the two members, locking them together. If the driven member tends to run faster than the driving, as in the case where a high-speed motor picks up the load from a slow-speed one, or the driving unit slows down as, for example, when stopping, the clutch immediately releases the load from the driver.

Different speed conditions do not affect the action of the cams, smooth engagement takes place immediately when the speeds of the outer and inner members synchronize, and a positive locking action without backlash results.

These clutches are built in sizes of 0.5 to 100 hp. at 100 r.p.m. and for free-wheeling speed of 5,000 r.p.m. for small sizes and 1,000 r.p.m. for large units. They are available in two designs: plain-type clutches intended primarily for ratchet, brake or back-stop use and for installation where a coupling is not required. It is a completely self-contained unit, in which the end plate is provided with threaded holes for attaching sprockets, gears, belt pulleys, ratchet arms or whatever may be needed for the drive. The other design combines a flexible coupling with the clutch, a combination used for more strictly free-wheeling purposes.

Principle of operation of the over-running clutch, Fig. 4, is that of a roller *R* running between an outer ring *O* and inner flat surfaces *S*. The outer member is the driving and the inner the driven. Rollers *R* are carried in guide rings *G* so that they remain equally spaced and are not affected by centrifugal force. Outer ring *O* is the driving member and flat surfaces are on the driven part. When ring *O* tends to run faster than the hub, rollers *R* wedge between the ring and flat surfaces and lock the two members together. If the driven member tends to run slower than the outer ring, then rolls *R* release and the clutch starts over-running.

Springs, not shown, hold the rollers in light running contact at all times with the outer ring and flat surfaces, so that there is no backlash in the clutch when changing from over-runing to loaded conditions. Even without the spring, rolls *R* cannot drop out of contact very far because of stop *S* limiting the release movement to the distance between it and pin *P*.

Ball bearings *B* support the outer ring on the hub and as the inner parts of the clutch operate in an oil bath, changing from load to over-running operation can occur with very little resistance.

These clutches are made in capacities of 0.33 to 220 hp. at 100 r.p.m. and for peripheral speeds up to 7,000 ft. per min. They are also available for practically every type of drive, either direct or through a belt, chain or gear. With modifications, they can be used as automatic single-revolution and positive-intermittent-drive clutches.

POWER is indebted to the Morse Chain Co., Detroit, Mich., and the Hilliard Corp., Elmira, N. Y., for assistance in preparation of this article.

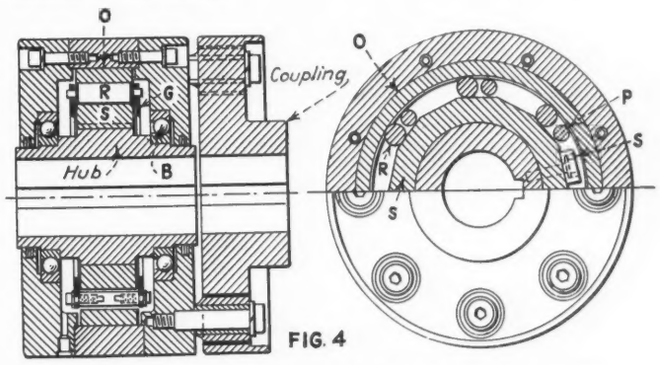


FIG. 4

Fig. 4—Rollers between an outer ring and inner flat surfaces form the clutching member of this over-running clutch. Fig. 5—A 175-hp., 1,500 r.p.m. motor connected by an over-running clutch to an 11-ton flywheel on a brake-shoe testing machine. Fig. 6—Free-wheeling clutch driven by steam turbine through reduction gear to centrifugal pump. An electric motor provides an alternate drive and is connected directly to the opposite end of the pump shaft

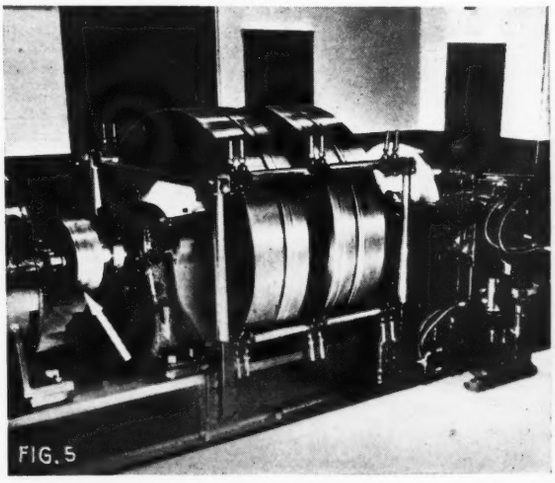


FIG. 5

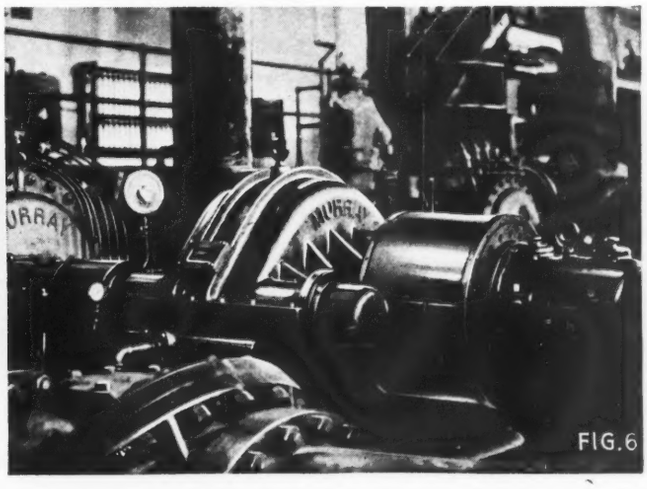


FIG. 6

How Lynn Insulated

By A. L. Sargent

Insulation Manager,
The Philip Carey Company, Boston, Mass.

A brass-tacks story of the insulation at Lynn Gas & Electric's new boiler plant. A practical article for practical men

LYNN Gas & Electric Co. enlarged its boiler plant in 1936. The insulation job (handled by Philip Carey Co., Boston, under supervision of Stone & Webster Engineering Corp.) involved some unusual problems. Their solution, outlined here in detail, should be of practical interest to other insulation contractors, and also to plant designers and operators.

Equipment installed last year included a standard Riley Stoker Corp. 4-drum, bent-tube, ring-flow boiler, built for 530 lb. w.p. Boiler operates at 430 lb. and 775 deg. F. at the superheater outlet.

Furnace is completely water cooled by bare-wall tubes. The 3-in. tiles are installed close to water-wall and boiler tubes, and the entire unit is steel encased, providing for 4 in. of insulation between tile and $\frac{1}{8}$-in. steel casing. Casing is of flanged-panel construction with closely spaced bolts to maintain air tightness.

Breeching and hot-air ducts, where the inside face is a part of the boiler casing, were designed to Riley standards, providing flexible joints for expansion. These surfaces were insulated with 3-in. Rocktex wool blankets and finished with $\frac{1}{4}$-in. asbestos wallboard. Wallboard joints were concealed by 16-gage metal batten strips, and exposed corners finished with $1\frac{1}{2}$x$1\frac{1}{2}$-in. 16-gage metal-angle trim. This asbestos-board finish gives hot-air ducts a clean, uniform appearance and eliminates the inevitable cracking of a hard plastic finish.

Asbestos-Board Panels

With this specification, however, a proper supporting angle-iron base to receive the asbestos board is essential. As 48 in. is a usual stock width of this material, the $\frac{1}{8}$-in. thick angle irons should be welded to the metal ducts $48\frac{1}{2}$ in. o.c. Size of these angle irons is determined by thickness of insulation specified. With insulation 3 in. thick, a 3x3-in. angle would be used. One leg of angle was welded per-

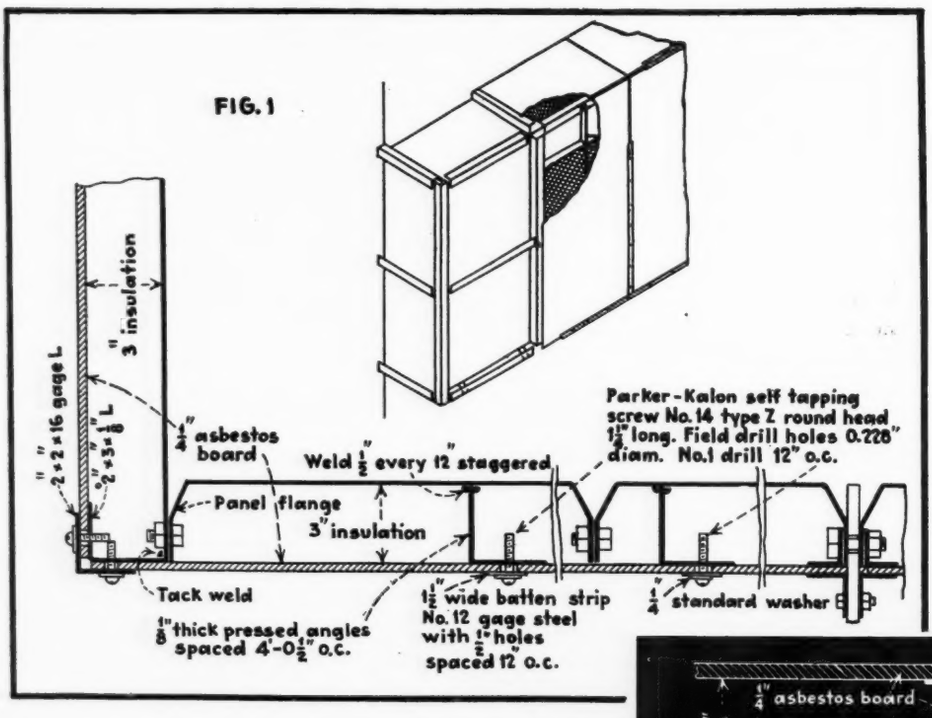


FIG. 1
3" insulation
2"x2"x16 gage L
2"x3"x⅛" L
¼" asbestos board
Weld ½" every 12" staggered
Parker-Kalon self tapping screw No. 14 type Z round head 1½" long. Field drill holes 0.228" diam. No.1 drill 12" o.c.
Panel flange
3" insulation
Tack weld
⅛" thick pressed angles spaced 4'-0½" o.c.
1½" wide batten strip No. 12 gage steel with ½" holes spaced 12" o.c.
¼" standard washer

Fig. 1—Angle irons support and protect asbestos-board finish on duct insulation

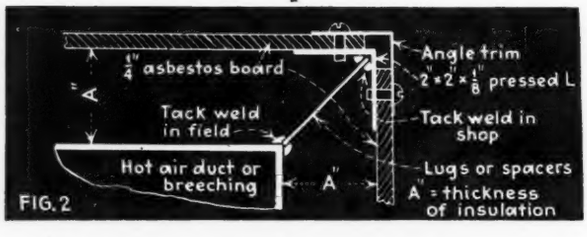


Fig. 2—Another method of supporting angle

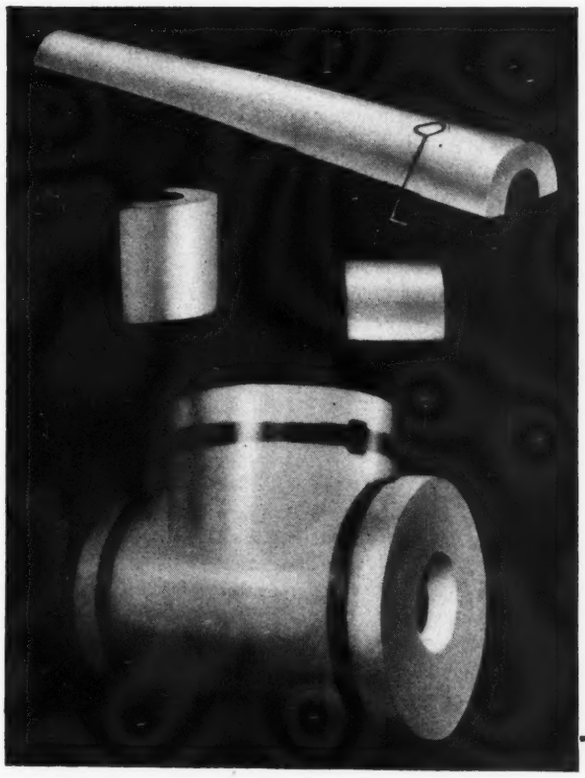


Fig. 3 (top photos)—Removable insulating panels (long panels and key panels) for superheater header

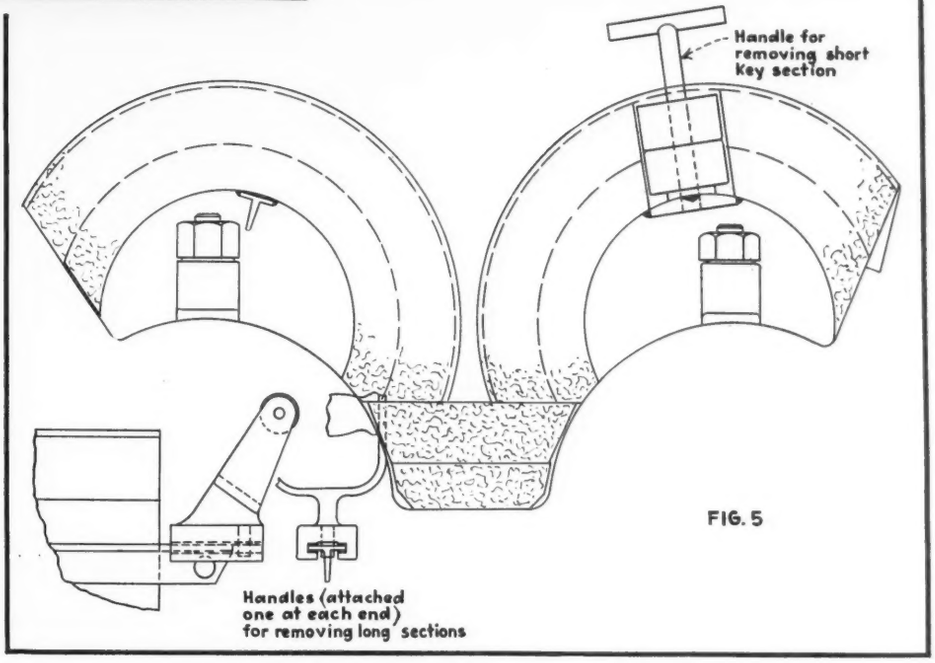
Fig. 4 (lower photo)—Removable cover (for 600-lb. flanged gate valve) can be removed safely in less than a minute

Fig. 5—Detail of superheater header insulating segments, showing method of keying for quick removal

Where no panel flange exists at an exposed corner, this supporting base must be provided in some other way. For example, Fig. 2, a $\frac{1}{8}$-in. pressed angle, at least 2x2 in., may be tack-welded to lugs or spacers in the shop. Lugs, with angle iron attached, may then be field-welded to exposed edges of duct in such a manner that angle legs are parallel to flat surfaces of duct. Spacers should be long enough to make distance *A* equal to thickness of insulation used. This design also gives an anchorage for the 16-gage angle trim used to finish exposed corners of the asbestos board.

Allowance for Expansion

Drillings in asbestos board should be $\frac{1}{2}$ in. to provide some extra clearance for a slight contraction and expansion of duct work. The $\frac{1}{2}$-in. space between panels also provides for such movement. If $\frac{1}{4}$-in. bolts are used for fastening, the metal batten strips should have $\frac{5}{16}$x$\frac{1}{2}$ in. slotted holes to avoid buckling of batten from expansion differences in angle-iron base. The same result may be accomplished by drilling the battens with $\frac{1}{2}$-in. holes and using the proper sized washers. It was found also that $\frac{1}{2}$-in. holes should be drilled in the angle trim and standard washers used with bolts or self



pendicular to duct surface; other leg, 3 in. away from and parallel to duct, forming a base for asbestos-board finish. Intermediate legs or angles should also be welded to duct to give additional support and rigidity. The angle-iron base for any surface must be as nearly in one plane as possible, and the asbestos board must be supported at all edges.

When a panel flange is located at a duct corner, a supporting base may be easily obtained (left end of Fig. 1). A $\frac{1}{8}$-in. pressed angle is tack-welded to the panel-flange edge, one leg of the angle being equal to thickness of insulation specified, the other leg of sufficient length (usually not less than 2 in.) to support properly the $\frac{1}{4}$-in. asbestos-board finish.

tapping screws. With that much slack, expansion differences between inside and outside angles will not tend to shear bolt fastenings.

The angle-iron supporting frame was drilled and tapped to receive $\frac{1}{4}$-in. bolt fastenings. A No. 12 or 14 Parker-Kalon Type "Z" self-tapping screw may be used to save labor in fastening to metal up to 6 gage (.203 in.). Success in the use of self-tapping screws depends upon following carefully the manufacturer's instructions regarding size of the drillings for various-gage screws. Theoretically a $\frac{3}{4}$ in. long screw or bolt would be adequate to fasten $\frac{1}{4}$ in. asbestos board. It is better, however, to use a minimum length of $1\frac{1}{4}$ in. (either stove bolt or self-tap-

ping screw) to allow for the supporting base's lack of flatness and the asbestos board's limited strength. This will insure anchorage, even though there may be some slight irregularities in the plane of the angle base.

It is important, also, not to make up bolt fastenings too tightly. After bolts or self-tapping screws have been turned up tight, back them off a quarter turn to allow a slight movement of the asbestos-board finish as the duct or breeching expands and contracts. From these comments, one can appreciate the difficulties arising in insulating flexible-joint ducts. By careful attention to detail, these problems can be solved and a permanent, satisfactory job obtained.

Flange Covers

The removable flange covers, specified by Stone & Webster for flanged fittings on piping between the superheater and desuperheater sections in drum 2, presented another problem. For this high-temperature service, an inner layer of 1½ in. thick Hi-Temp No. 12 and an outer layer of 1½ in. thick 85% magnesia, with ½-in. plastic finish, was used. Past practice usually called for building up this flange insulation over a heavy hardware-mesh base. The cover would be made in two halves and fastened in place by wires or bands.

For low-pressure work involving standard or 1½ in. thick insulation, this method has proved reasonably satisfactory, but it presents practical difficulties in high-temperature service, where the heavier Hi-Temp No. 12 is used in conjunction with 85% magnesia and total thickness of insulation runs from 3 to 4 in. The weight of insulation and lack of a rigid base make such flange covers very difficult to remove and replace without damage.

Use Black Iron Base

A special design for insulated flange covers and fitting covers, patented by the Boston Removable Insulation Co., eliminates previous objections to their use. These covers were used on the Lynn job, not only for the flanges on the line from superheater to desuperheater, but also for the bodies of valves and special fittings. An 18-gage black iron base was fabricated and welded to conform to the flange, or body and flanges in the case of flanged fittings. This base was usually made in two half sections and entirely enclosed the equipment. Tie ups to secure the insulation were welded to the metal base.

Insulation consisted of 1½-in. thick Hi-Temp No. 12 and 2 in. thick 85% magnesia with a hard-finish coat of plastic. The two half sections of insulated cover were then held in place with 2 in. wide, 20-gage, solid-brass bands with riveted draw buckles.

Fig. 4 shows such a removable cover designed for the 600-lb. flanged gate valve. Although the weight of this complete cover is approximately 150 lb., two men can easily remove the two sections in less than a minute, exposing the valve body, valve flanges and bonnet flange. This permits quick and easy access to stud bolts, so necessary on high-temperature service. The design protects against damage by water; steam or water leaks cannot destroy the insulation.

Superheater Headers

Another problem arose in connection with the insulation of the two superheater headers. These are in the roof of the boiler setting, so that hand holes are readily accessible and operation of expanding the superheater tubes simplified. To support insulation on water-wall headers, it has been the custom to weld angle irons along both sides of the row of hand holes. Outstanding legs were punched with holes to receive tie wires securing the insulation, which terminates at the angles. This left the area between the angles, occupied by the row of hand holes, uninsulated.

The resulting heat loss would not be serious at lower temperatures, but with superheater headers at 800 deg. F., good practice demands complete insulation of all exposed surfaces. To accomplish this and keep handholes accessible, removable insulated panels or segments were used, Fig. 4. These were made up on a 16-gage black-iron base, different segments varying from 18 to 29 in. in length with a key section approximately 12 in. long. The metal base was shaped to give clearance to handholes and studs; then 3½ in. of Carey Hi-Temp, with hard plastic finish, was secured to the base in the same manner as for the removable flange and fitting covers.

A special handle, shown in Fig. 5, permits removing the 12-in.-long key sections on each header. Two handles facilitate removal of the long segments, as shown at left of Fig. 5. These were designed to slide over the 6-in. light T irons extending 3 in. out from each end of the individual panel. The T irons were tack-welded to the under side of the 18-gage sheet metal base and staggered to allow each segment of insulation to butt tightly against the adjacent segment.

The result was a completely insulated superheater header with no excessive heat loss from exposed handholes. At the same time, accessibility to handholes was retained. Construction was so rigid and solid that even with frequent removal and replacement of these insulated segments, there should be a notable absence of expensive insulation maintenance and repair.

Routine Work

The rest of the Lynn job involved the usual insulation work common to latest power-plant design. Air preheaters, induced-draft fan, flues and precipitator were covered with two layers of 85% magnesia block to give the advantage of broken-joint application. High-temperature service lines were covered with the combination Hi-Temp No. 12 and 85% magnesia insulation. Normal temperature lines (500 deg. F. and under) were covered with 85% magnesia.

The only justification for this article was the thought that our experience in meeting the special problems encountered on this particular job might be of some value to other contractors in our industry. While the pioneering in any line of endeavor introduces unanticipated costs and lays heavy demands on time and energy, there is satisfaction in the knowledge that previously accepted standards have been surpassed.

Steam-Engine Control—III

Application of control to steam engine-driven compressors, cookers, pumps and exhausters is discussed in this, the concluding article of the series

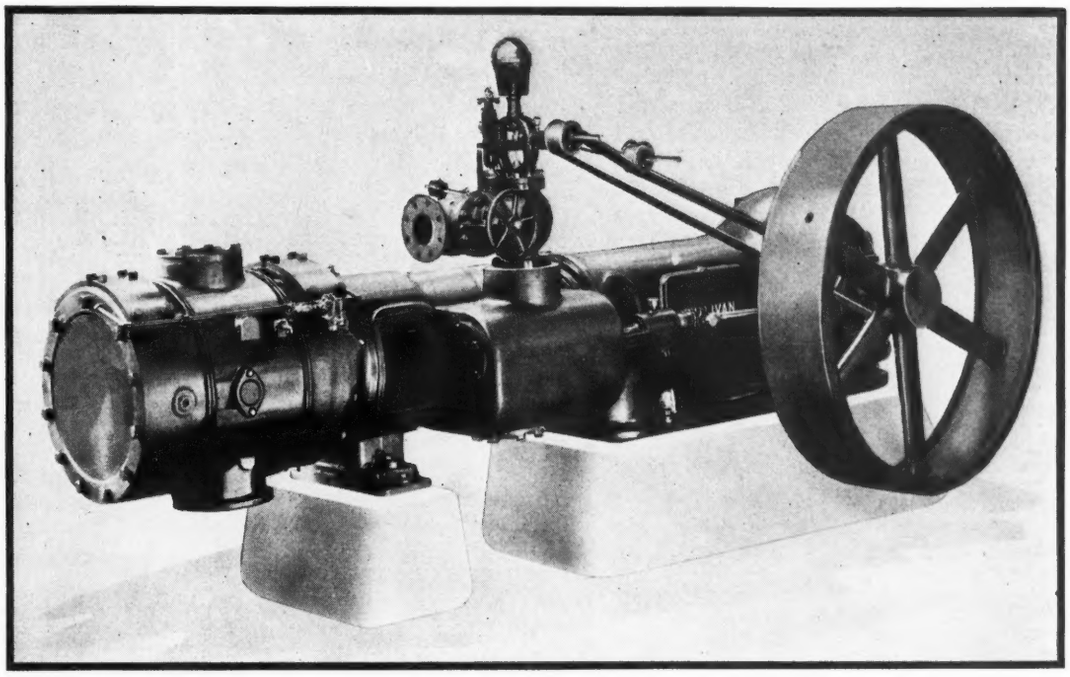


Fig. 19—Engine-driven air compressor with speed control

By F. J. Vonachen

Troy Engine & Machine Co.

TWO PRECEDING articles described various types of steam-engine governors and discussed their application to engines driving boiler auxiliaries, such as fans and stokers. This article deals with the application of steam-engine controls to other engine-driven equipment.

In most cases when a steam engine drives a refrigeration compressor, the standard flyball throttling governor to vary engine speed manually and to maintain constant engine speed for a particular governor setting, satisfies the requirements.

Automatic temperature control can be secured by using a pressure-actuated pilot switch to control a conventional type of diaphragm throttle valve in the steam-supply line. The pilot switch can be actuated by compressor suction. Small pilot valves responsive to temperature changes in the cooled space can also be used. With such arrangements, the standard throttling or automatic governor is used as a limiting speed control, and engine speed is reduced to idling speed when the control is in the "off" position. Especially in air-conditioning work, the wide speed range of the steam engine is an advantage.

Automatic cut-out to stop the unit in case of dangerously high head pressure due to failure of condensing water supply or to some accidental cause, can also be installed. It is usually a mercoid limit switch which actuates a valve in the engine steam supply line. Similar cut-outs or alarms can also be installed for excessive decrease in suction pressure, high temperature of lubricating oil or failure of oil pressure.

Pumps

Delivery from engine-driven pumps should, for best economy, be controlled by engine speed. The controlled condition can be pressure, flow, differential pressure, or liquid level.

Some pump types can be operated with constant engine speed. For others, manual control with adjustable speed is satisfactory, and this can be secured with a standard throttling governor, or if a wider speed range is required than 4 to 1, or exceptionally close speed regulation is needed, a variable-speed transmission can be added, as shown at *A* in Fig. 20. In this case, breakage of the leather belt between the transmission and governor operates the automatic governor stop and shuts down the engine. The transmission is connected to the engine crankshaft by chain, and although it is usually not considered necessary to protect for the remote chance

of chain breakage, in this case an automatic flywheel governor was also used to serve as an auxiliary speed-limiting control.

Pumps can be automatically controlled by a pump governor (Fig. 21) in which a diaphragm or piston is actuated by pressure of the liquid to be controlled. Movement of the diaphragm controls steam supply to the engine, engine speed, and maintains constant pressure.

In some applications, it is necessary to control at more than one pressure, for instance, in impregnating various kinds of lumber with creosote or coal tar where the desired pressure on the charging cylinder may be 60 lb. for soft pine or 200 lb. for oak. This can be accomplished with a pressure control which employs, for instance, low air pressure and a turn-key device so that the control can be set for the various pressures desired. When these pressures are reached, the control limits supply of steam to the engine, reducing engine speed to maintain the desired pressure: A safety stop valve can be installed ahead of the regular pump governor to shut off steam supply and stop the unit in case of a loss in pressure due to a break in the discharge line.

At times a steam-engine-driven pump is required to maintain a certain liquid level, for instance, in atmospheric and vacuum towers in refinery work, (Fig. 22). This is accomplished with a liquid-level controller, that consists of an external float chamber in which float position is determined by liquid level in the tower. The float actuates a balanced lever valve controlling steam supply to the engine and discharge from the pump.

Air Compressors

Usually one of two control types is used with air compressors depending on air requirements. Simplest is the "constant-speed" type in which the engine always operates at the same speed and the compressor loads and unloads through a pilot valve according to requirements for compressed air. Only engine regulation necessary is the regular throttling or automatic governor to maintain constant speed. The throttling governor can be adjusted to give the most desirable constant engine speed, while it is necessary to run the automatic governor at the speed for which it was constructed. But the automatic governor will be more economical than the throttling type. A disadvantage of this control, especially if air consumption is not fairly constant, is the higher steam consumption due to running the engine constantly at high speed. This type of control is modified in some installations by addition of a no-load regulator which reduces engine speed to an idling point whenever the compressor is unloaded. This modification requires careful application.

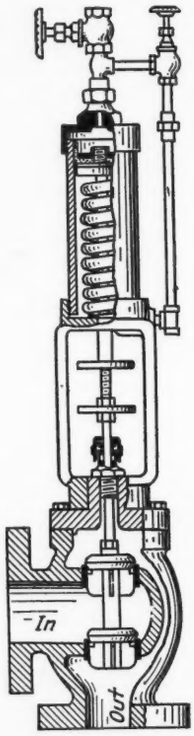
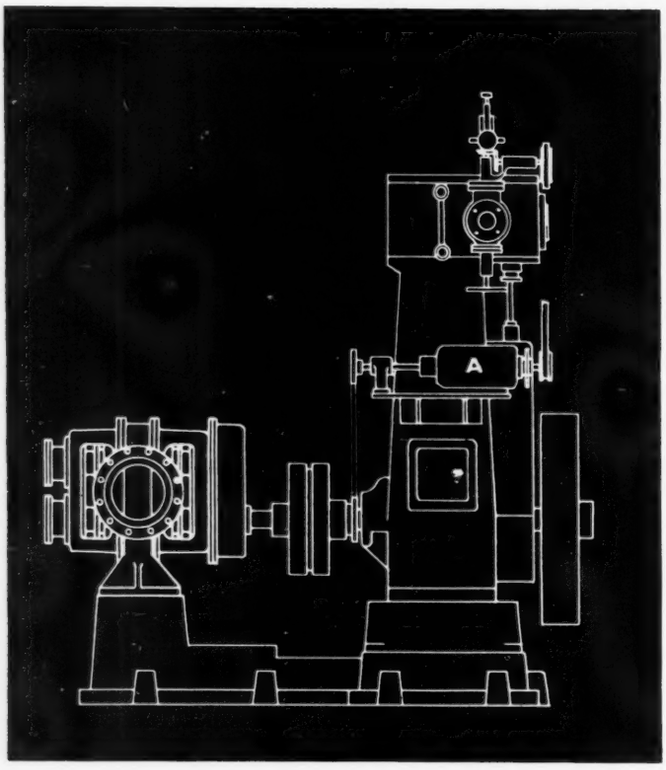


Fig. 21—Directing-acting pump governor in which discharge pressure acts on spring-loaded piston

The second type is the "adjustable-speed type," (Fig. 19). This is used where demand for air is intermittent and where it is desired to take advantage of economy that results from slowing the engine during periods of low air consumption. An engine regulator actuated by air pressure decreases steam supply and slows down the engine as the air pressure increases. If air pressure continues to rise, with the throttling valve of the regulator nearly closed, the compressor itself is unloaded, and the machine continues to operate at no load and slow speed. The engine does not speed up when the compressor is unloaded, as air pressure is maximum, keeping the regulator throttling valve in its idling position. Any increase in air demand lowers the air pressure which loads the compressor, opens the regulator throttling valve, and supplies more steam to the engine to take care of the increased demand. A standard throttling or automatic governor is used as a speed-limiting control. With the throttling governor, it is possible to adjust at any time for the maximum and idling speeds desired.

Fig. 20—Variable-speed transmission driving engine governor provides close control of engine speed and pump discharge



Cookers, Exhausters, Gas Compressors

Operation of a steam-engine-driven cooker can be automatically controlled by temperature of the material that is being cooked. The engine runs at constant speed during the cook so the more economical automatic flywheel governor can be used to control engine speed. A control actuated by temperature of the material shuts off steam supply when the cooker reaches a predetermined temperature and shuts down the engine, stopping the cooker and preventing overcooking.

Some exhausters are controlled by hand throttling,

with the throttling or automatic governor as a limiting speed control. Others run at constant speed and a pressure governor bypasses excess gas.

Gas compressors are often controlled with the Huntoon steam regulator, in which a float, subjected to gas pressure and balanced by a weight, is mechanically connected to a rotary or balanced valve in the steam-engine line. The throttling or automatic governor is used for speed-limiting control. A diaphragm-actuated regulator loaded with a weight or spring can be substituted for the Huntoon governor, especially for higher pressures.

In larger engines, one arrangement (Fig. 23) controls engine speed by varying cut-off through a hydraulic cylinder operated with oil pressure. Movement of the piston is controlled by a pilot valve connected to a float, which is actuated by suction line pressure. This hydraulic cylinder can also be used to control the variable-speed mechanism of the standard throttling governor.

A governor (Fig. 24) similar to the above hydraulic control is sometimes used, in which a small blower, belt driven from the engine, furnishes air to the pilot valve of the float. This air pressure is piped to an air cylinder and connected through a lever to the variable-speed flyball throttling governor so that the speed of the engine is controlled by both float and blower. The advantage of this arrangement is that it prevents overtravel. For example, suppose exhauster suction increases, calling for a decrease in speed. The float will close the pilot bleeder valve and cause the piston in the air cylinder to raise, shutting off steam. This slows down the engine, reduces the supply of air from the small blower, and the piston in the air cylinder will drop back to a new position, thus giving a compensation.

An objection to the air-type regulator is its bulkiness, consequently electrical controls are often used. There are times when the control of exhauster speed must not only take care of the suction but must anticipate a drop in suction that will come from movements of butterfly valves in collector mains. The electrical hook-up also helps to prevent surging or interference between butterfly pressure governors and the speed governor. Exhauster regulation, therefore, becomes a matter of plant control more than unit control. For example, the control that must be kept accurate in byproduct coke-oven work is at the ovens, and that particular governor must be master of the situation. Pressure at the exhauster must be reasonably uniform, but sometimes it is better to have pressure vary at the exhauster, because, due to the effect of the flywheel, the engine cannot change speed fast enough to take care of the rapid pressure changes at the ovens.

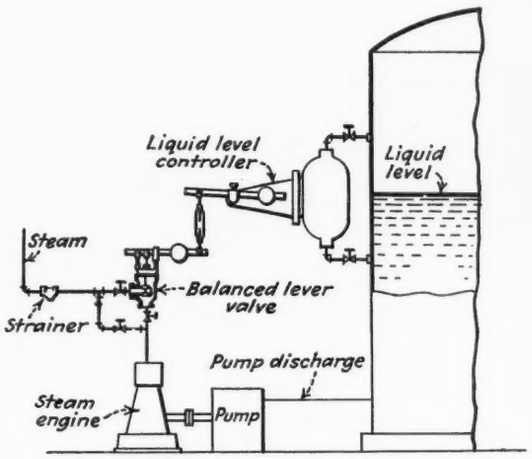


Fig. 22—Engine-driven pump operating under float control

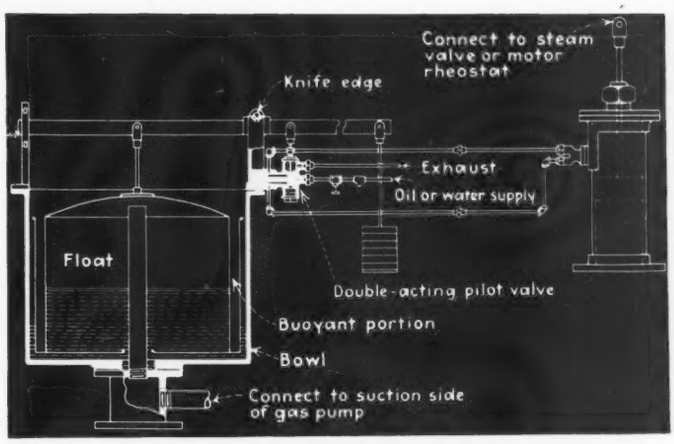


Fig. 23—Control for regulating speed of engine (driving a gas exhauster) and suction pressure

In general, any condition that can be measured, can be controlled manually or automatically. Control problems can readily be solved by contact with the control manufacturers. Connection of the control to the steam-engine drive is usually quite simple.

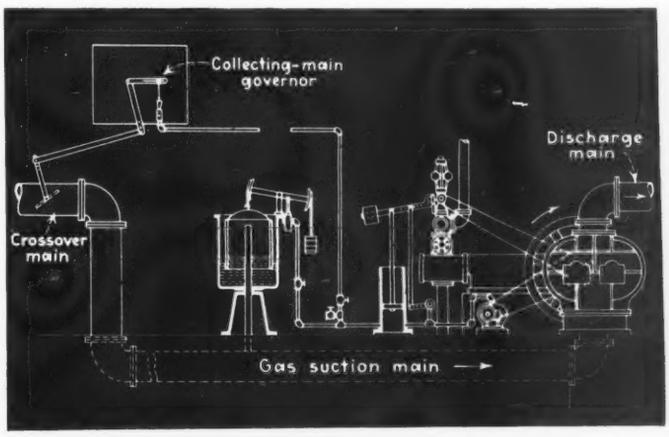


Fig. 24—A control that synchronizes damper operation and speed of engine-driven gas exhauster

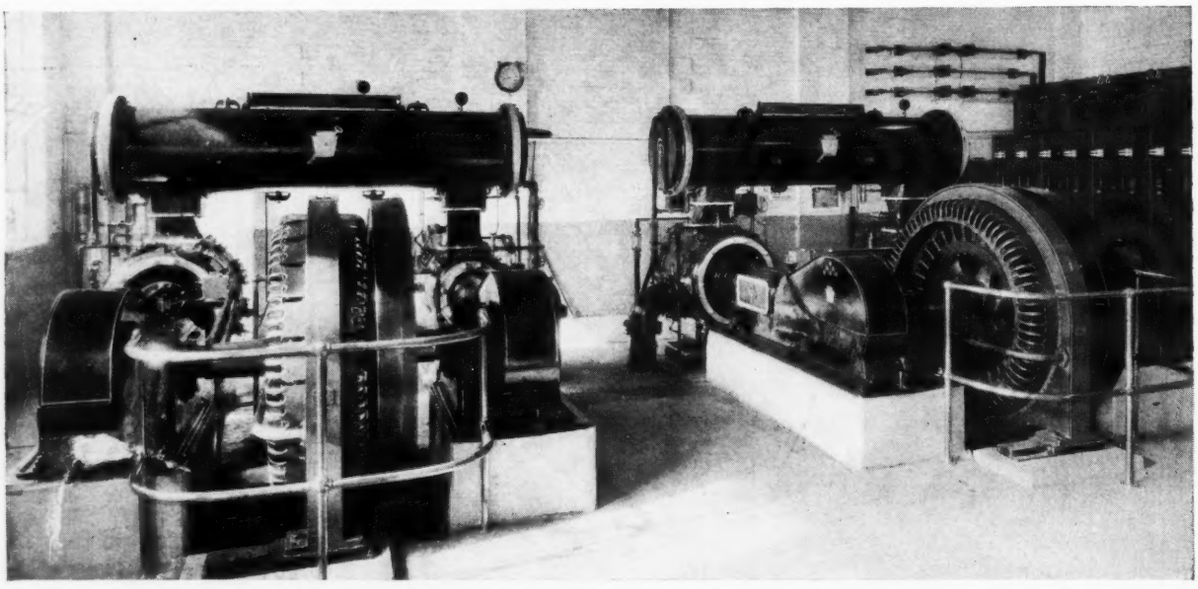
Assistance in obtaining data and illustrations is gratefully asknowledged from:

Power, A. W. Cash Co., Fisher Governor Co., Ruggles Klingemann Co., American Engineering Co., American Askania Corp., Bailey Meter Co., Baker Ice Machine Co., Carrier-Brunswick International, Carrick Engineering Co., Foster Engineering Co., *Power Plant Engineering,* Spence Engineering Co., Leeds & Northrup Co., National Transit Pump & Machine Co., Detroit Stoker Co., Roots-Connersville Blower Corp., Sullivan Machinery Co., Cincinnati Butchers' Supply Co., Woodward Governor Co., Waters Governor Co., Riley Stoker Corp., Kinney Manufacturing Co., York Ice Machinery Corp., Frick Company, Inc., B. F. Sturtevant Co., Buffalo Forge Co., Foxboro Co., Worthington Pump & Machinery Corp.

Starters for Air-Compressor Motors

By M. N. Halberg
Industrial Department, General Electric Company

Mr. Halberg, from his experience, lists the types of starters to use on single-phase-induction, polyphase-induction, synchronous and direct-current motors applied to air-compressor drives



Two 300-hp., 225-r.p.m., 2,200-volt synchronous motors driving air compressors in a cement plant; power and starting panels on right

FOR MANY air-compressor motor applications, several types of starting equipment are available. Which to use depends upon several factors: whether manual or automatic starting or speed control is desired, type of motor, compressor started loaded or unloaded, type of electrical protection preferred, etc. The following suggestions will prove helpful in answering these problems.

Single-phase motors, either repulsion-start induction, repulsion induction, or capacitor-type, are all suitable for full-voltage starting, and in most cases full-voltage starting is acceptable. A double-pole switch, either manually or electrically operated, combined with an overload relay mounted in a sheet-metal enclosing case, forms the starter. For electrically operated switches, a pushbutton station, either mounted in the cover of the enclosing case or for separate mounting, is also required. In the small sizes (3 hp. and below at 220 volts) the pressure switch normally used in a pilot control circuit to start and stop the motor may be used directly as a motor starter, the contacts of the switch opening and closing the power circuit to the motor.

Where reduced-voltage starting is necessary, a resistor-type starter is commonly used. This may consist of a manual face-plate rheostat or a resistor short-circuited by magnetic contactors, with suitable timing means for closing them in sequence.

Modern polyphase squirrel-cage induction motors are generally suitable for full-voltage starting, even in the large sizes. Full-voltage starting is very generally acceptable on smaller motors (5 hp. and below), but in larger sizes, the power company should be consulted to determine if reduced-voltage starting is necessary.

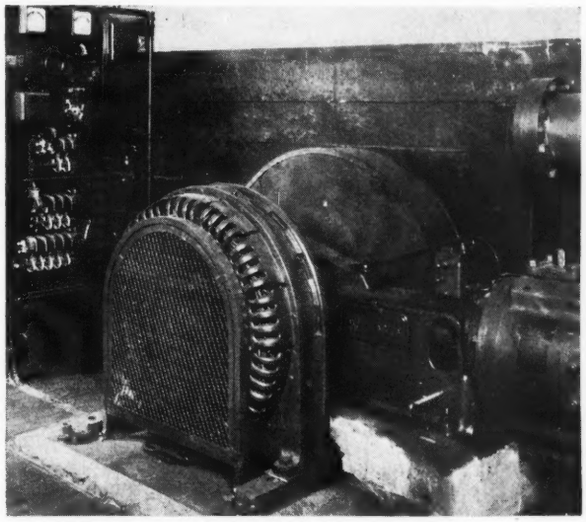
Full-voltage starters comprise a 3-pole switch either manually or electrically operated, and an overload relay mounted in an enclosing case. Autotransformers are most commonly used on reduced-voltage starters, together with necessary switches for transferring from reduced-voltage taps to full voltage. Magnetic reduced-voltage starters require a relay, usually of the definite-time type, for initiating the transfer from starting to running connections.

Increment-type reduced-voltage starters employ a resistor for reducing the voltage, with contactors and a time relay for short-circuiting the resistor in steps until full voltage is applied. Number of steps necessary depends upon motor starting current and allowable increment of current which may be drawn from the power line. Power-company regulations frequently do not limit the total amount of

current, but require that it be built up in steps, each step not to exceed a certain value. With such a rule, increment-type starters can be used even though the compressor starts under load, which may require applying full voltage to start the motor.

Full-voltage primary controllers are always used with wound-rotor induction motors. This is acceptable, since by inserting resistance in the secondary circuit, starting current can be kept down to a value proportional to the starting torque required. Secondary control normally comprises a resistor with contactors or drum switch, or a face-plate rheostat for varying the amount of resistance in the circuit. The primary control should be interlocked with the secondary control so that the motor cannot be started unless all resistance is in circuit. If operation at reduced speed is required, a continuously rated resistor must be used to prevent overheating under continuous service.

Synchronous-motor controllers include equipment for controlling the d.c. field circuit as well as the primary circuit. The primary-circuit control is essentially the same as that for squirrel-cage induction motors and may be either manual or magnetic, full-voltage or reduced-voltage. Since low-speed synchronous motors, such as are used for direct drive of air compressors, draw rather low starting currents (250 to 300% of full-load value), full-voltage starting is almost always acceptable. Such motors have fairly low starting torque so that reduced-voltage starting should not be employed without checking carefully the torque required to



A 40-hp., 500-volt, 300-r.p.m. synchronous motor directly connected to a 250-lb. pressure air compressor; motor started on full voltage from panel on left

start the compressor, to make sure that the motor will develop this torque on reduced voltage.

Practically all synchronous-motor controllers include an automatic means for applying d.c. excitation to the field winding. A magnetic contactor with actuating relay is necessary. A field-discharge resistor must be provided and the control arranged so that whenever the field contactor opens, the field is short circuited through the discharge resistor. A rheostat (or fixed resistor with taps) must be provided for adjusting the excitation current of the motor. If an individual exciter is employed for each motor, an exciter-field rheostat is all that is required; but if more than one motor is excited from a single d.c. source, each must be equipped with a comparatively large motor field rheostat.

Relays for removing field excitation automatically whenever the motor pulls out of step are also available and desirable. They are particularly useful on installations where the compressor is provided with an automatic unloader. The unloader can be electrically interlocked with the field contactor so that removal of field excitation causes the compressor to be unloaded and a reapplication of field excitation loads the compressor. With this arrangement, should the motor pull out of step because of overload or a momentary dip in line voltage, the field will be removed automatically and the compressor unloaded. When normal conditions are restored, the motor can resynchronize and load will be applied automatically. One type of field-removal relay operates on the drop in power factor, which occurs when a synchronous motor pulls out of step.

Direct-Current Motors

Very small d.c. motors ($\frac{1}{2}$ hp. and below) are usually started on full voltage, with a 2-pole manually or magnetically operated switch. Larger motors are usually started with a reduced-voltage, resistor-type starter. Manual reduced-voltage starters employ a drum switch and resistor or a face-plate rheostat. A magnetic contactor is frequently provided for opening the line circuit, particularly on 550-volt equipment. Magnetic starters employ contactors for shorting out the starting resistance, and accelerating relays for closing contactors in proper sequence. In some cases the time-delay feature is built into the contactor itself. For adjustable-speed operation by field control, a field rheostat is also required.

Continuity of service is often important in air-compressor drives. Improvement in this respect often can be obtained by the use of time-delay undervoltage protection rather than by instantaneous undervoltage protection on the motor controller. This prevents the motor from shutting down on short dips or momentary failure of line voltage. Time-delay pushbutton stations are available which, when used with magnetic starters, give time delay rather than instantaneous undervoltage protection. Manual starters can usually be provided with a built-in, time-delay undervoltage device.

In the case of low-speed synchronous motors, little is to be gained by time-delay undervoltage protection unless the compressor is equipped with an automatic unloader and field-removal equipment is provided on the control panel. Without the automatic unloading equipment, the synchronous motor will drop out of step unless the dip in voltage is of extremely short duration; and since the motor cannot be synchronized under load, an interruption to service is unavoidable. However, with an automatic unloader and automatic field-removal equipment, the compressor is unloaded when the motor pulls out of step, after which it can be resynchronized.

Speaking of Power

In these days of labor disturbances, *American Machinist* discovers a little Utopia — a machine shop in Chicago with 28 employees. All equipment is replaced every seven years as a matter of policy. Well or sick, the men are paid a weekly salary, get a ten-day vacation with pay, and bonus money twice a year. . . . Quality of work is so high that no inspector is needed. In fourteen years only three men have been added to the personnel, but production has increased four-fold, chiefly through the purchase of high-capacity machine tools. The work week is five days, but generally eight or ten men drop in on Saturday morning to work without extra pay, just because they feel like it. No employee has ever quit voluntarily. . . . That kind of an organization can work that way. Most places couldn't get away with it. It takes the right size and location, a certain type of manager, very highly selected workers and years of spade work.

. . a little Utopia

At a recent meeting of the Iron & Steel Electrical Engineers, William Stanier said that mechanical power transmission equipment represents about 3% of the total production-equipment cost. The average life of such equipment is six years, if properly applied, but only four years with improper application. Stanier's figures were based on many years of experience in 84 chemical plants and should interest *Power* readers. . . . Frankly, I was surprised at the short life of the equipment, and am wondering whether this might be due in part to the especially severe conditions in the chemical industry. Perhaps some readers will have comments.

. . severe conditions

The other day I heard a lot of experts speak on labor relations. One observation struck me as common sense. Here's the story: In bad times the American worker acts like his European brother. He is then interested only in security — holding his job. When times pick up, the real American looks for better pay, better working conditions. He also figures on getting ahead, which is something else again. It means stepping up in dignity — from unskilled worker to skilled or from skilled to assistant foreman, for examples. . . . Now, here's the rub. Many managements have raised the wages of the unskilled faster than these of the skilled. This leaves the A-1 men on a lower pedestal relatively. It means that they get less prestige and satisfaction from their jobs. It leaves a less-exciting goal for men down the line. Management should not forget to make ambition worth while.

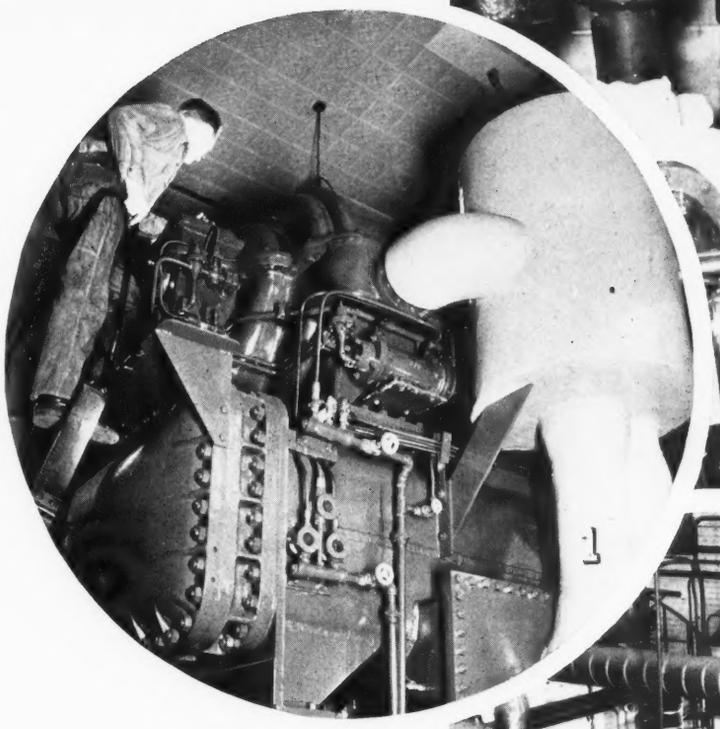
As I read current engineering literature, I sometimes suspect that the more technically inclined are getting too far away from everyday mechanical realities. . . . After all, pages of differential equations are nothing more than symbols— useful, of course. The real things are wood, glue and patterns, foundries, sand and pig iron, rolled-steel shapes, machine tools, welding rod, pistons, cranks, gears and so on. Why not go out and take a good look at them now and then? The old Yankee mechanics did, and made tremendous inventions with no mathematics higher than plain arithmetic. . . . This is not a plea to abandon mathematics; we can use a lot of good mathematicians. But engineering needs other types of thinking as well — notably, the direct application of horse sense and mechanical ingenuity. Even the mathematicians admit that mathematics can produce nothing new. It merely gives out what they put in the hopper, but chopped fine and rearranged. Progress demands creative intelligence as well as analysis.

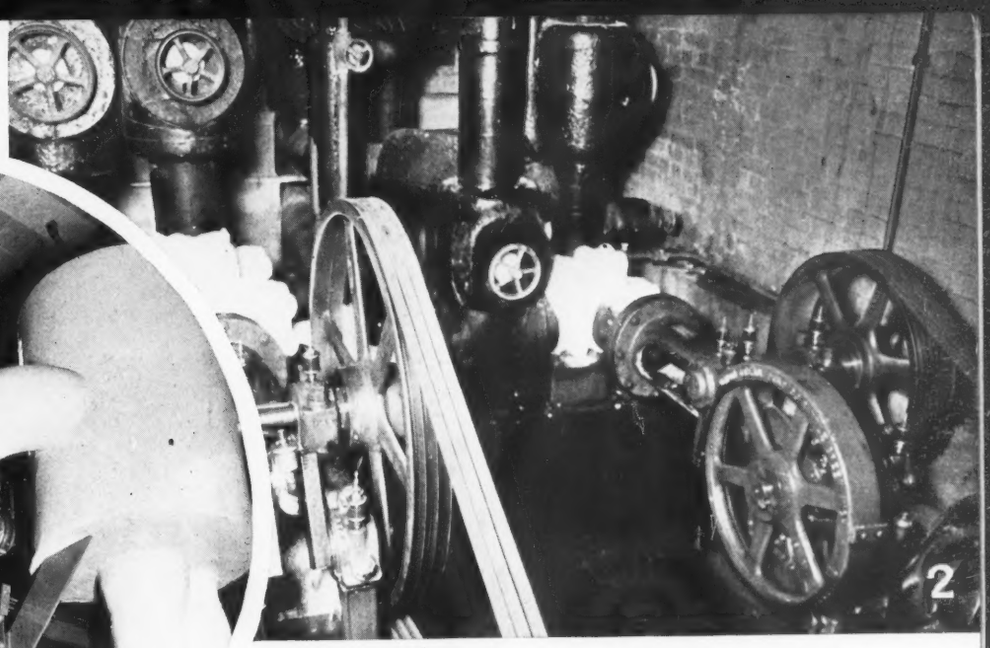
. . Yankee mechanics

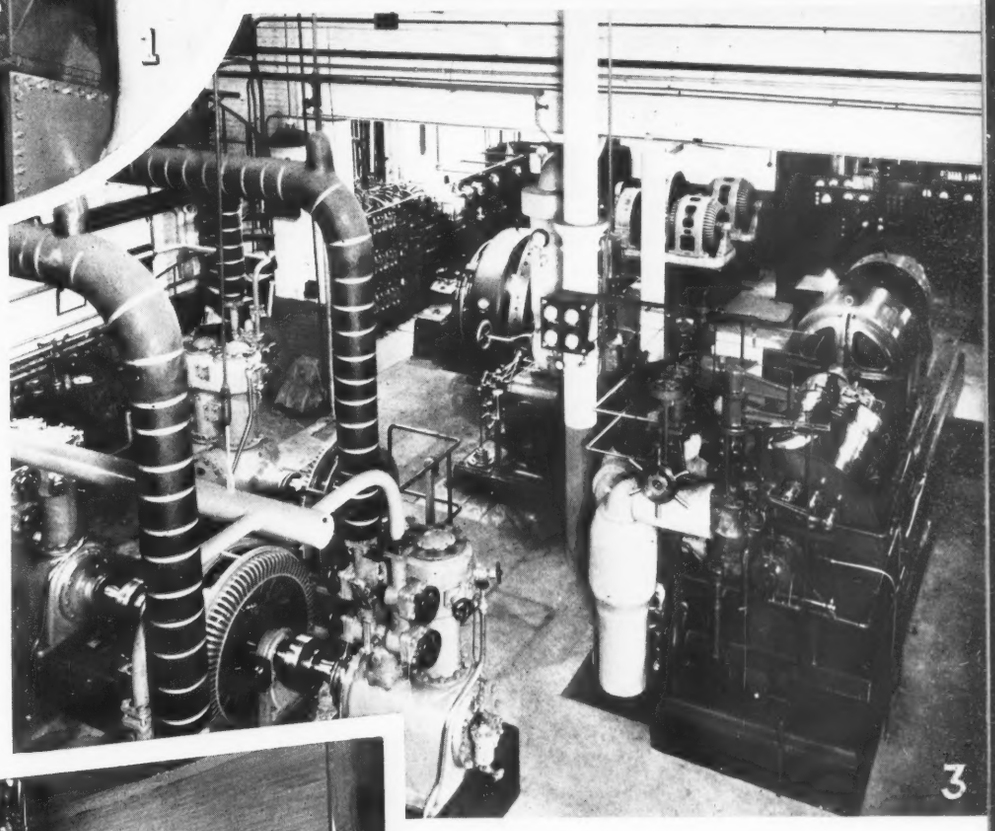
And here's a related thought: The conviction grows that the great age of invention is not in the past, but in the future. We shall see many of the things we have dreamed of, and some of which no man has yet dreamed. . . .Development of these inventions will require many types of skill. We need dreamers to pull us out of the rut and hard-headed business men to pull the dreamers back to earth. We need metallurgists and mathematicians. We need the old-style Yankee mechanics. We need economists (but not the fake variety). We need men who can sell and distribute — stir up latent desires for the things some men can build and others can use. . . . In fact, we need about everybody who can do something worth while that a machine can't do. Those who can't may expect to have an increasingly hard time.

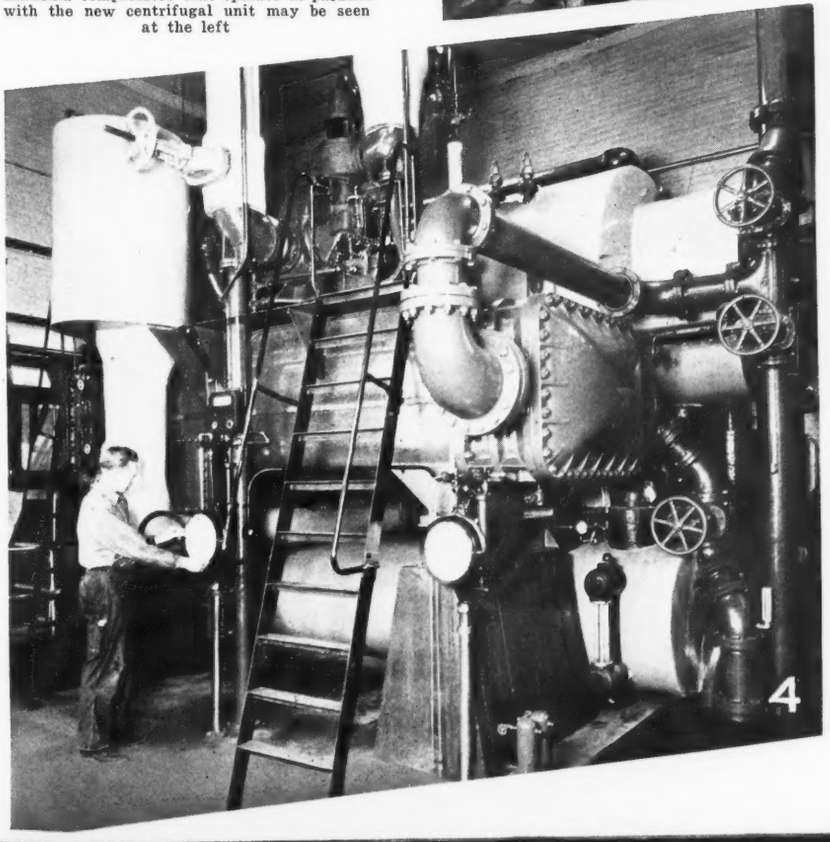
. . we need dreamers

PHIL SWAIN,
Editor









1 and 4

Turbine-driven 350-ton Carrier refrigeration unit liquefies ammonia returning from a direct-expansion system. Low-pressure liquid ammonia collects in the receiver shown below the unit in Fig. 4. The turbine receives steam at 140 lb. pressure and exhausts at 30 lb. to either the mixed-pressure turbo-generator or to process depending upon demand for process steam by the brewery

2

Reciprocating pumps take low-pressure liquid ammonia from the receiver and discharge to the old high-pressure liquid ammonia system with which the new unit operates in parallel

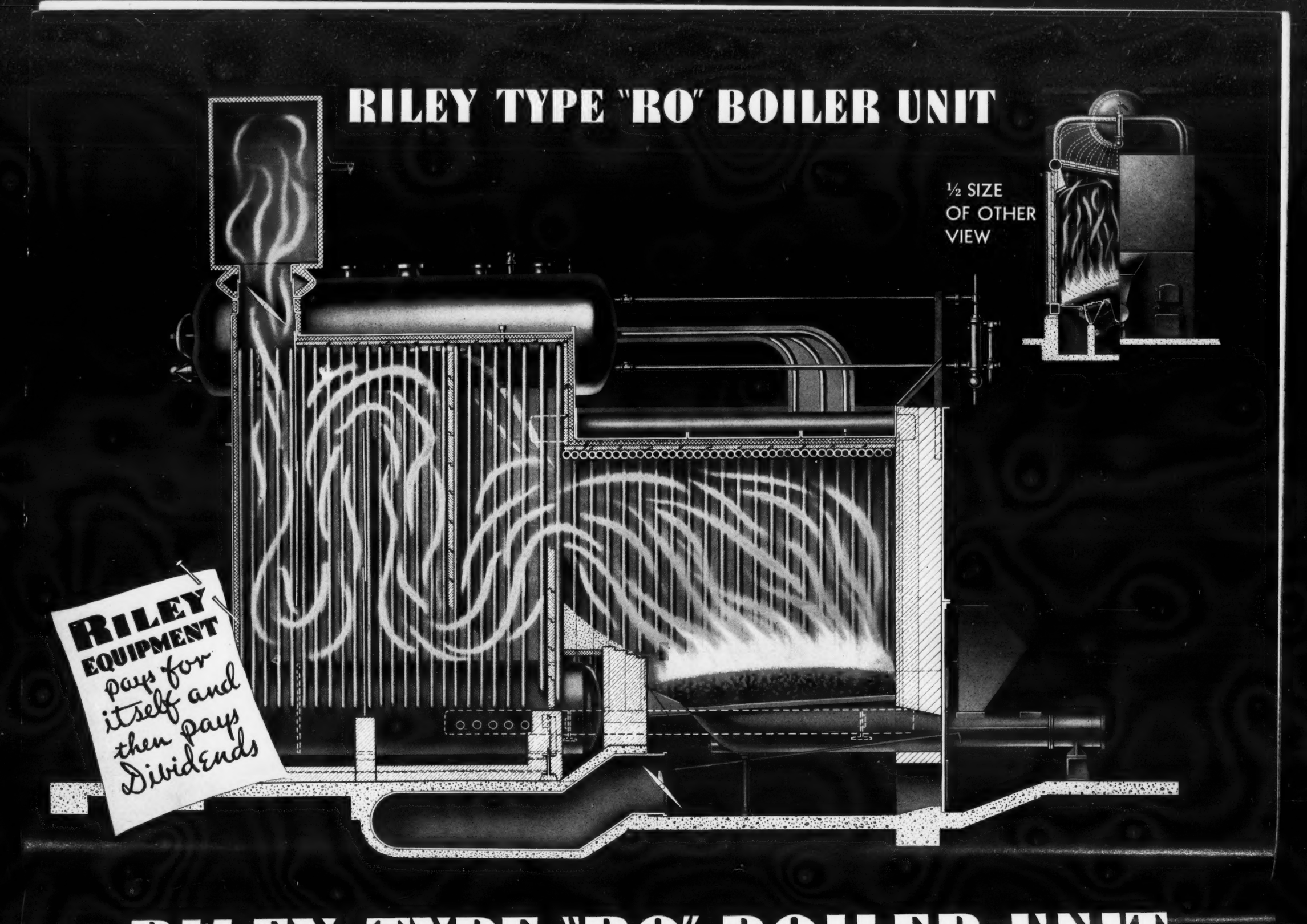
3

New Terry 450-kw., mixed-pressure bleeder condensing turbo-generator at the right supplied with 140 lb. steam from the oil-fired boilers bleeds steam to the brewery at time of high process steam demand or uses 30-lb. exhaust from the compressor turbine when process steam use is low. Conventional ammonia compressors that operate in parallel with the new centrifugal unit may be seen at the left

Cold for Heat Balance

To satisfy a need for more refrigeration at P. Ballantine and Sons brewery, a 350-ton centrifugal compressor using Carrine No. 2 to liquify ammonia has been installed. This turbine-driven unit operating with a new 450-kw. mixed-pressure bleeder condensing turbo-generator has greatly improved brewery heat balance

RILEY TYPE "RO" BOILER UNIT



RILEY TYPE "RO" BOILER UNIT

RILEY TYPE "RO" BOILER UNIT

complete with fuel burning equipment

One Contract-Undivided Responsibility

Having developed large steam generating units to a high degree, Riley engineers have turned their attention toward the development of complete steam generating units for capacities under 40,000 pounds of steam per hour. With the development of the Riley type "RO" unit, it is now possible for users to obtain units of moderate size having the efficient performance characteristics found formerly only in large units and to purchase such units complete with fuel burning equipment under a single contract with undivided responsibility.

Riley type "RO" boiler units operate at unusually high efficiency due to their distinctive design characteristics, including economizer and water-cooled furnace, and the fact that boiler and fuel-burning equipment are properly co-ordinated.

As Riley manufactures all types of stokers, as well as pulverized coal equipment and oil and gas burners, Riley units can be purchased for burning the most economical fuel. In addition to moderate size units, as illustrated, with capacities from 7,500 to 40,000 pounds of steam per hour, Riley also manufactures and installs complete larger steam generating units for any desired capacity or pressure.

having these distinctive advantages

ECONOMIZER SECTION

An economizer section built integral with the boiler assures low flue gas temperatures and a minimum loss of heat up the stack.

HIGH EFFICIENCY

The design of the Riley type "RO" Boiler provides an efficient transfer of heat from the gases to the boiler water which, together with the effect of the economizer section and the high combustion efficiency due to the proper co-ordination of boiler and fuel-burning equipment, results in unusually high performance efficiencies.

RAPID POSITIVE CIRCULATION

The Riley type "RO" Boiler is designed to assure rapid unrestricted positive circulation.

WATER-COOLED WALLS AND ROOF

The side walls and roof are water cooled. When used with Side Dump Stoker, the side water wall headers act as a clinker chill at the dump line. With a completely water-cooled furnace, clinker difficulties are prevented.

RELIABILITY AND LOW MAINTENANCE

With rapid positive circulation, heat is quickly carried away by the boiler water, preventing tube failures due to overheating and reducing scale formation. As refractories are protected with water cooling, brickwork maintenance is practically eliminated.

SMALL SPACE REQUIREMENT

Riley type "RO" Boilers can be installed where floor space and setting height are limited. At least twice as much steam can be obtained from the same floor space as from an HRT boiler.

ADAPTABLE TO ALL TYPES OF FIRING

The Riley type "RO" Boiler is adaptable to all types of firing—stokers, pulverized coal, oil or gas.

RILEY

STOKER CORPORATION

WORCESTER, MASSACHUSETTS

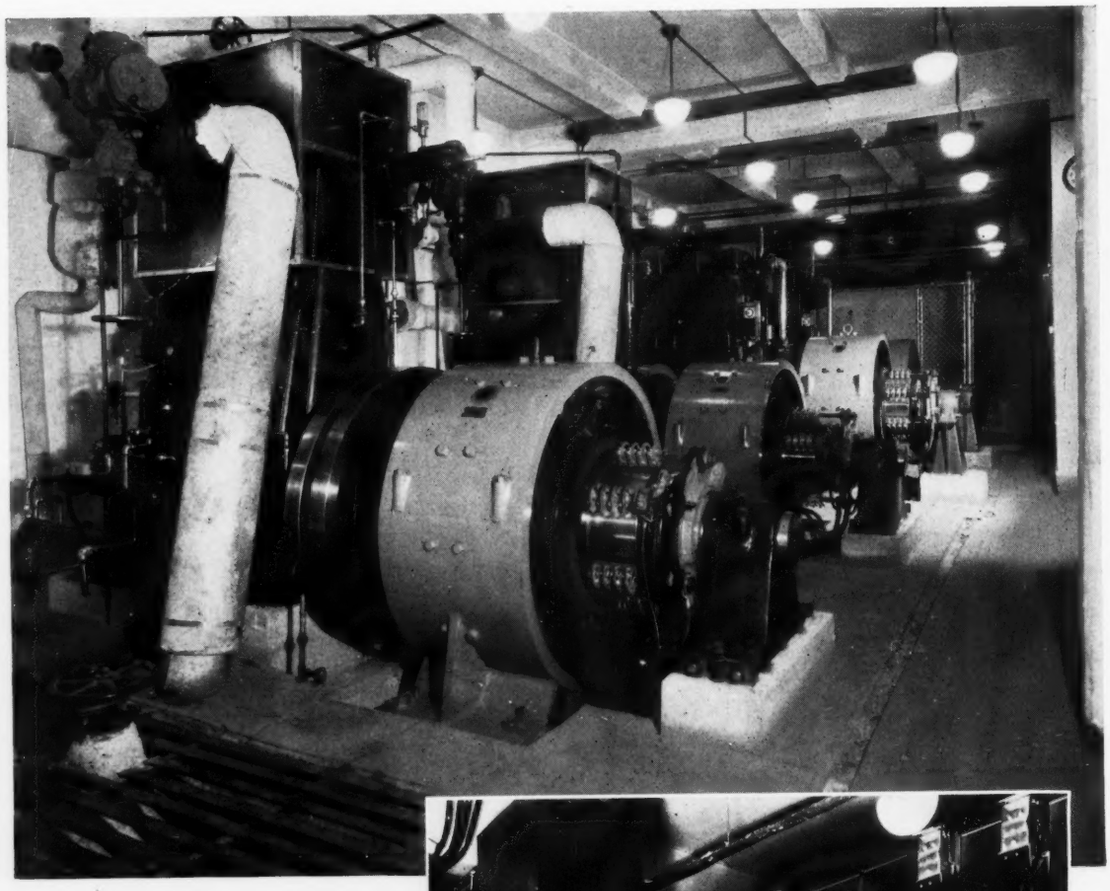
COMPLETE STEAM GENERATING UNITS

BOILERS - SUPERHEATERS - AIR HEATERS - ECONOMIZERS
PULVERIZERS - BURNERS - STOKERS - WATER-COOLED FURNACES
STEEL-CLAD SETTINGS

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta New Orleans

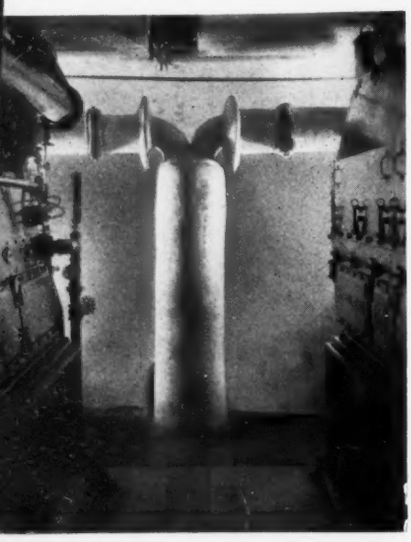
Bank Balance

INSPIRED by the success of their similar, but smaller, plant at the Ice Club (*Power*, March, 1936), now saving $15,000 per year, owners of the Empire Trust Bldg. and the 1-11 W. 47th St. Bldg., New York, have installed a combined steam-diesel plant which took load last Dec. 20. There is no outside standby. Peak loads run about 450 kw. Savings the second month over purchased steam and power were over $4,000, indicating that the plant will pay out in 3½ years. It was designed and construction supervised by Harry J. Smith, supervisory engineer for the owners, and is being operated by Charles Weder as chief engineer. The space was Brentano's shipping room.



Below

Diesel exhaust lines have expansion joints formed of welded, dished, 3/16-in. plates. The two 5-in. exhaust lines elbow down different lengths into a 12-in. pipe containing baffles, and their ends are cut at an angle to break up the gas stream still more. In case of repairs, either exhaust line can be cut off by a simple slide plate. The 12-in. exhaust line passes through a Maxim silencer 24 ft. long to the 3-ft. square brick building stack. All piping, and most piping supports, are welded. No. 4 special diesel fuel comes from a 3,000-gal. welded-steel tank

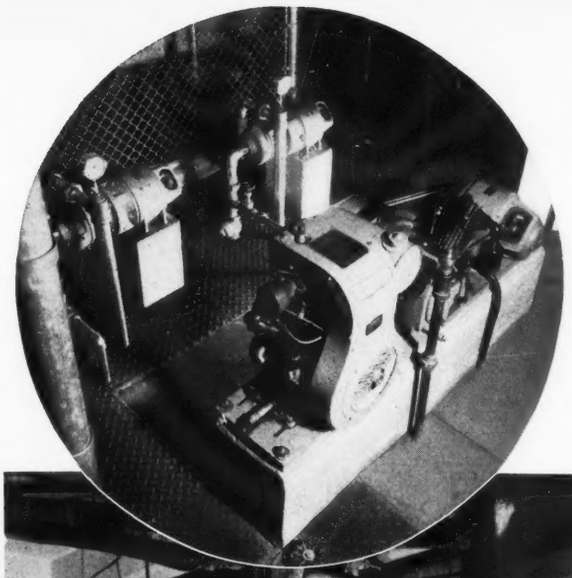


Above

Two 3-cyl. 450-r.p.m., 10x11-in. Ames uniflow steam engines and two 250-hp., 4-cycle, 5-cyl., 10x12-in., 514-r.p.m., Ingersoll-Rand solid-injection diesels each drive a 150-kw., 600-amp., welded-frame Crocker-Wheeler d.c. generator. Diesels have Woodward governors, twin Purolator fuel filters, SKF outboard bearings. All engines are on one concrete slab 5 ft. thick, isolated from the rock foundation by 6 in. of sand, and from the basement floor by 3 in. of sand all around. All current is generated at 250 volts, and each 3-wire generator has a special 125-volt, 150-amp. takeoff for night loads

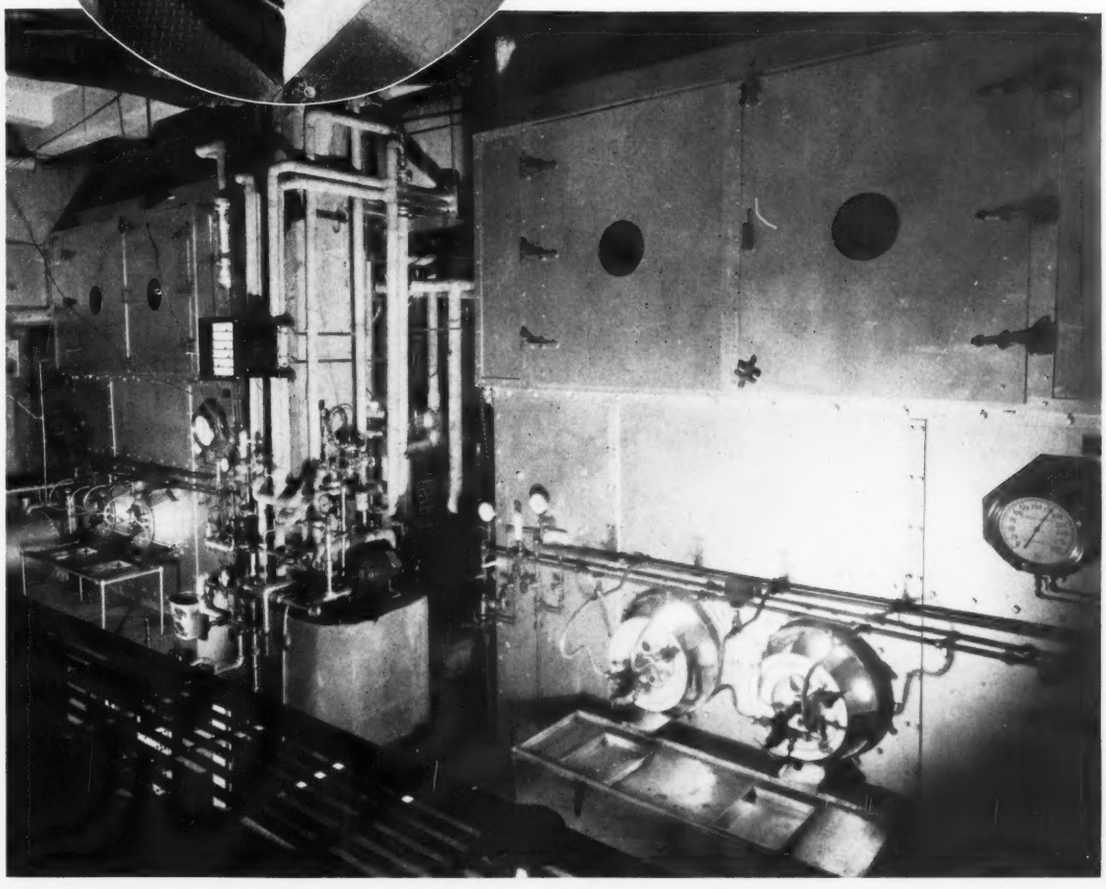
Right

The 7-panel Standard switchboard has one panel for each prime mover, a light-and-power panel, a pyrometer panel (Brown 12-point), and an integrator panel. Norton instruments and Sangamo watt-meters are used. D. Coyne did the electrical work



Left

Enough diesel jacket water is recirculated by the two I. R. Cameron motorpumps (100 g.p.m. @ 35-ft. head) driven by 1½-hp. G. E. motors to maintain 130- to 150-deg. inlet temperature. Temperature is controlled by hand regulation through a Walworth valve and check valve arrangement on city supply. Excess 160-deg. outlet water goes either to boiler feed or to waste. A Wisconsin 3¼x4-in. 1-cyl. gasoline engine or a 1750-r.p.m., 3-hp. G. E. motor can be Dayton cog-belted to the Ingersoll-Rand starting-air compressor. Welded compressed-air tanks are above the compressor

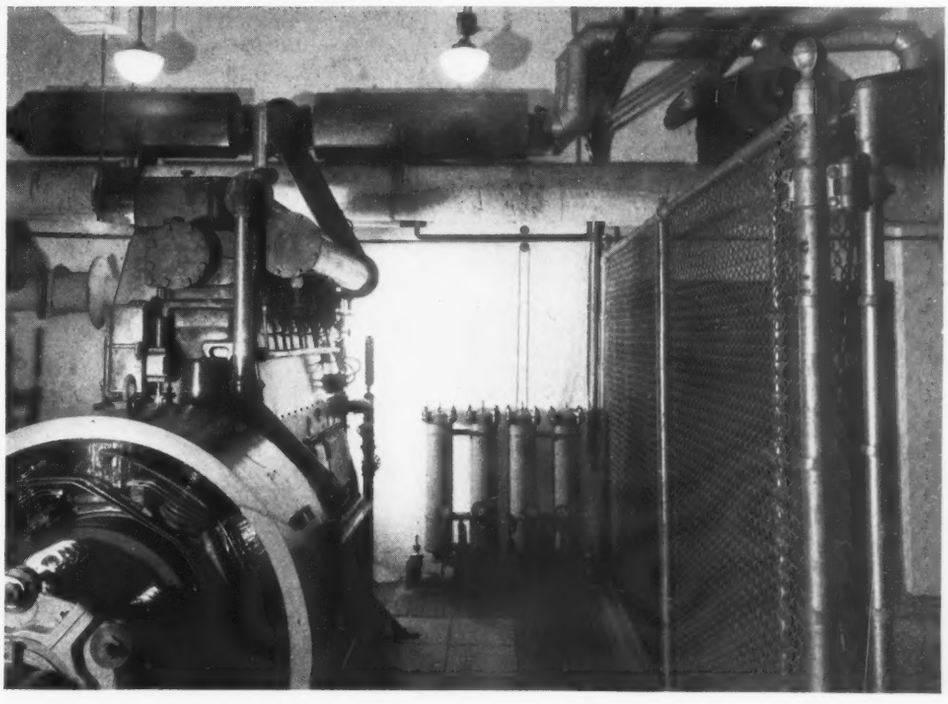


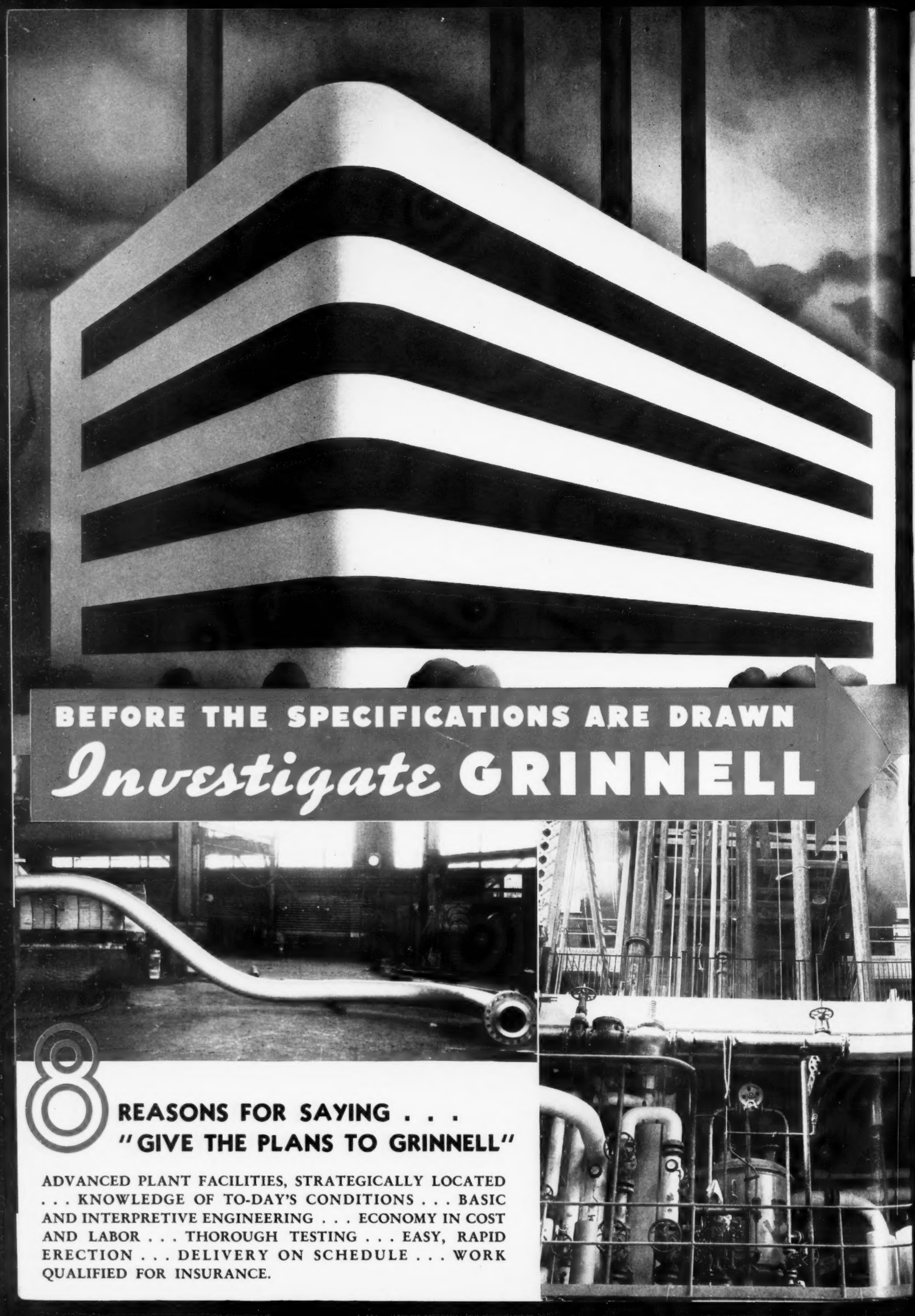
Below

Twin Nugent oil filters are provided for each engine. Intake air enters through separate American filters, then passes through separate Maxim silencers to each engine. Bells and lights warn of lubricating-oil pressure under 5 lb. or jacket water above 175 deg. Diesels have SKF outboard bearings

Above

Two 2,225-sq. ft. Keeler straight-tube boilers provide saturated steam at 185 lb. No. 6 fuel oil from a 7,000-gal. welded storage tank (combined with diesel-oil tank under the sidewalk) is fired through two Peabody burners per boiler. Copes feedwater regulators, Vulcan soot-blowers, Yarway blowdown valves, and Wright-Austin water columns are fitted. Auxiliaries between boilers include steam- and electric-driven fuel pumps, two steam-driven Worthington boiler-feed pumps exhausting to a Worthington open feedwater heater, and feed water filter, also supplied directly from a low-pressure steam receiver if necessary. Instruments include Republic flowmeters, draft gages, CO_2 meters (average around 14%) and steam integrator, and a Boiler Room Equipment smoke detector. Steam enters a welded high-pressure receiver over the engines, capacity intended to be enough to take care of fluctuating elevator-load demands. Exhaust at 1 to 3 lb. enters the welded low-pressure receiver leading to the building service and heating systems. A reducing connection between receivers takes care of abnormal steam demands



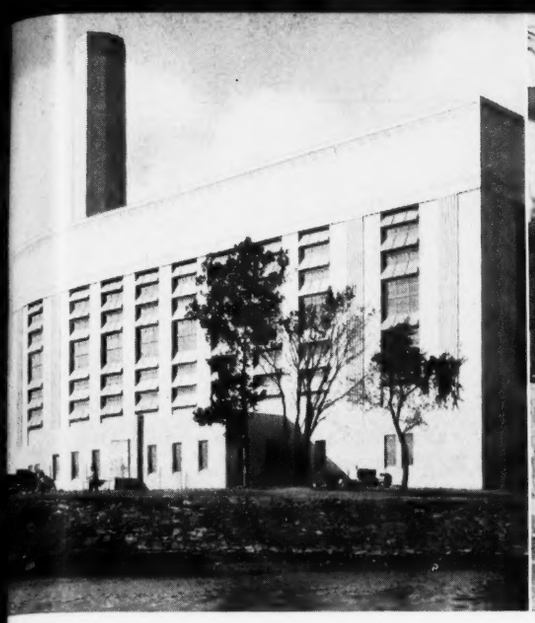


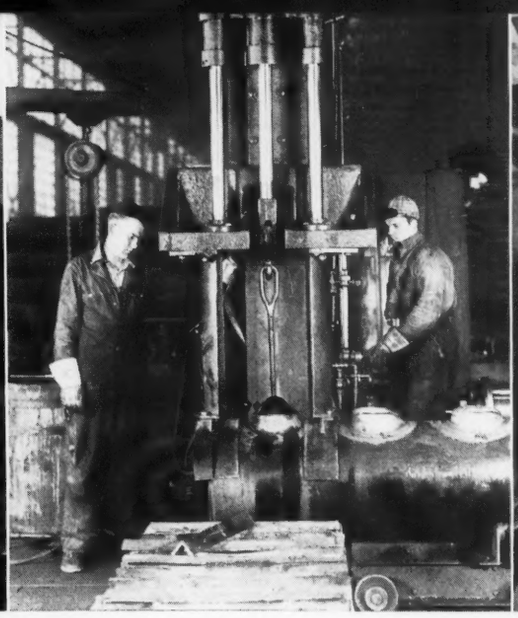
BEFORE THE SPECIFICATIONS ARE DRAWN

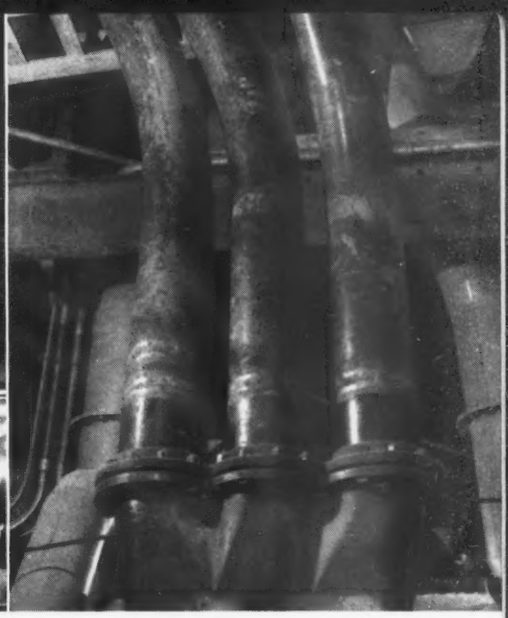
Investigate GRINNELL

8 REASONS FOR SAYING . . . "GIVE THE PLANS TO GRINNELL"

ADVANCED PLANT FACILITIES, STRATEGICALLY LOCATED . . . KNOWLEDGE OF TO-DAY'S CONDITIONS . . . BASIC AND INTERPRETIVE ENGINEERING . . . ECONOMY IN COST AND LABOR . . . THOROUGH TESTING . . . EASY, RAPID ERECTION . . . DELIVERY ON SCHEDULE . . . WORK QUALIFIED FOR INSURANCE.







WHEN your power or process installation is still in the planning stage, look into Grinnell Prefabrication! Discover the technical advice Grinnell can give your engineers. Find out how much more readily prefabrication can provide those complicated piping sections, multiple outlets, unusual bends. You'll learn that Grinnell Prefabrication limits field welds to the minimum — and even those are plain circumferential butt welds. That Grinnell Prefabricated Piping is smooth in contour and inside surface, is thoroughly pretested and may be qualified for insurance.

Remember, it takes an organization like Grinnell to provide the resources for complete prefabrication. To provide the advanced plant facilities, the 1937 thinking, the years of experience and the *responsibility* that back every Grinnell installation. Grinnell Co., Inc., Executive Offices, Providence, R. I. Branch offices in principal cities.

PREFABRICATED PIPING

"BE SURE YOU ARE RIGHT . . . THEN GO AHEAD"

. . . it applies to prefabrication as well! Be sure your prefabricator limits welds to plain circumferential butt welds, insofar as possible. Be sure you get clean lines, inside and out. Be sure your prefabricator's welders are qualified under A. S. M. E. code.

Grinnell's qualifications have fitted this company for a broad scope of work, which has included Steam Electric Generating Plants, Paper Mills, Tire and Rubber Plants, Coal Conveyors, High Pressure Electric Stations, Mining Operations, Automobile Plants, Oil Refineries, Steel Plants.

INTERESTING PICTURE STORY

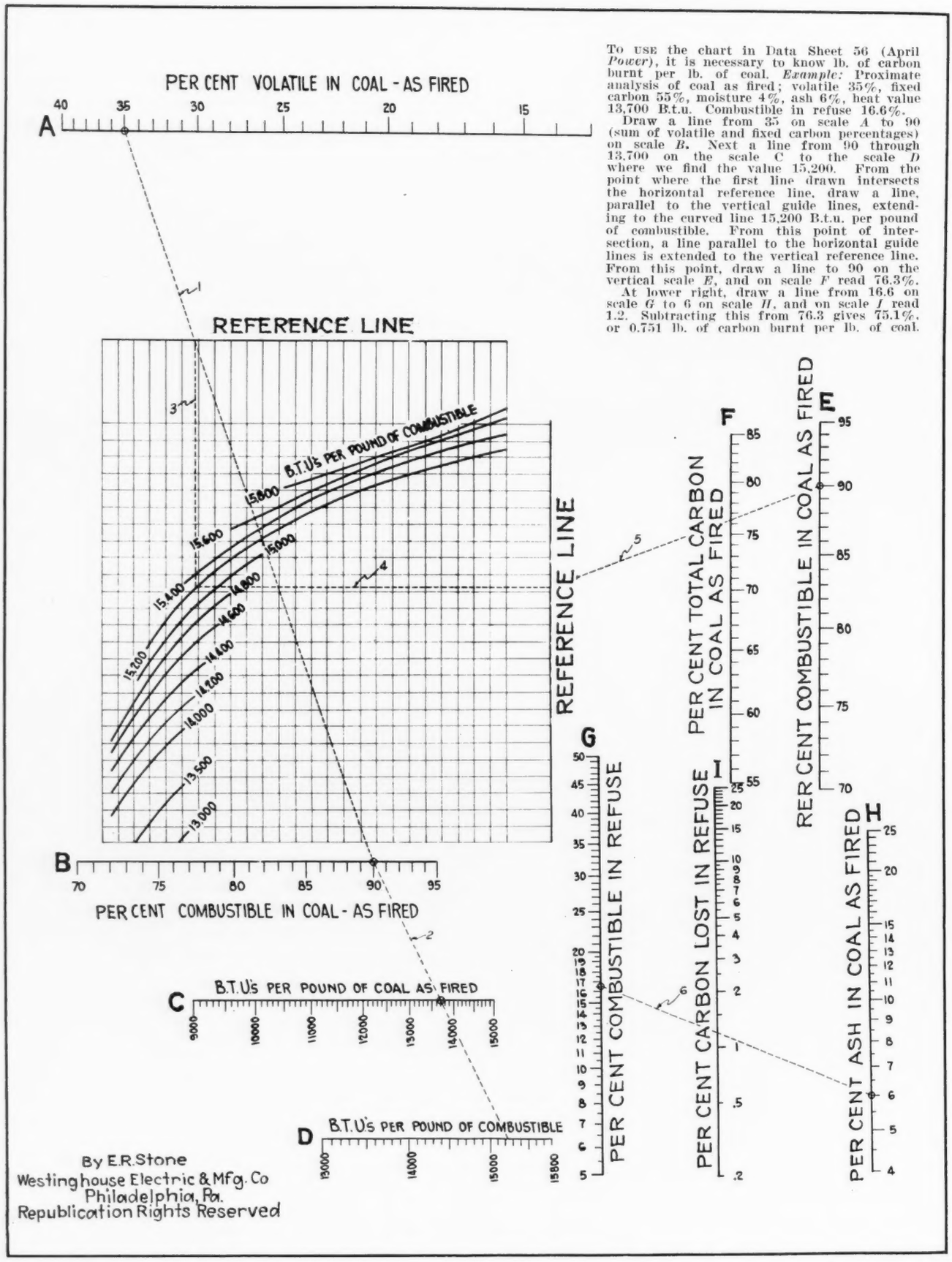
This booklet, free on request, shows close-up photographs of many of the interesting applications of Grinnell Prefabricated Piping. Send for your copy.

GRINNELL

WHENEVER PIPING IS INVOLVED

Number 57

Carbon Burnt Per Pound of Coal



To use the chart in Data Sheet 56 (April *Power*), it is necessary to know lb. of carbon burnt per lb. of coal. *Example:* Proximate analysis of coal as fired; volatile 35%, fixed carbon 55%, moisture 4%, ash 6%, heat value 13,700 B.t.u. Combustible in refuse 16.6%.

Draw a line from 35 on scale *A* to 90 (sum of volatile and fixed carbon percentages) on scale *B*. Next a line from 90 through 13,700 on the scale C to the scale *D* where we find the value 15,200. From the point where the first line drawn intersects the horizontal reference line, draw a line, parallel to the vertical guide lines, extending to the curved line 15,200 B.t.u. per pound of combustible. From this point of intersection, a line parallel to the horizontal guide lines is extended to the vertical reference line. From this point, draw a line to 90 on the vertical scale *E*, and on scale *F* read 76.3%.

At lower right, draw a line from 16.6 on scale *G* to 6 on scale *H*, and on scale *I* read 1.2. Subtracting this from 76.3 gives 75.1%, or 0.751 lb. of carbon burnt per lb. of coal.

By E.R.Stone
Westinghouse Electric & Mfg. Co
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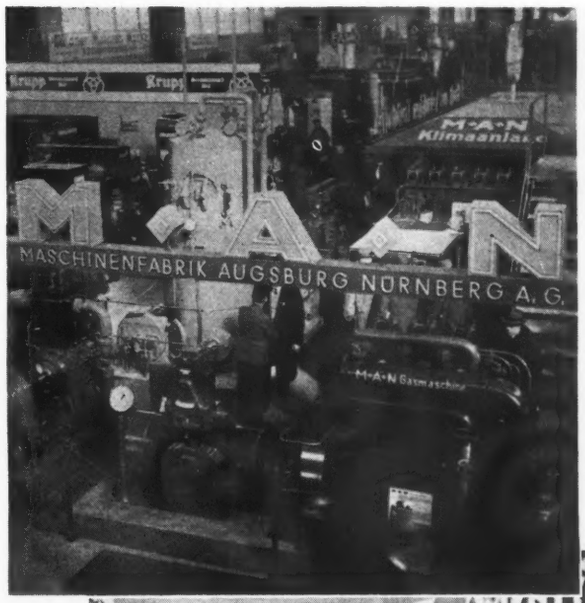
In the Limelight at Leipzig

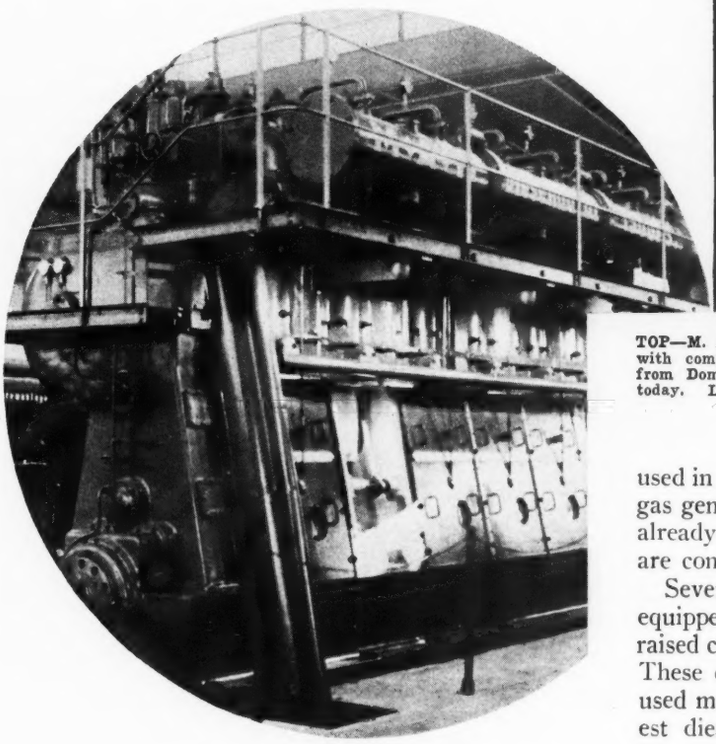
By Dr. F. Isermann

LAST YEAR, the editor of *Power*, Philip Swain, here in Leipzig for the Fair, remarked that the *D* in Deutschland has long stood for *Diesel*. After viewing the exhibits in this year's Fair, I am prompted to say that today the *G* in Germany stands for *Gas*. The Power and Heat section of the 1937 Leipzig Engineering Fair, organized and patronized as usual by the German Association of Machine Builders of Berlin, comprised exhibits from well over 100 manufacturers.

Gas engines were very noticeable, particularly so in the further development of the convertible diesel, designed for an internal working pressure of up to 600 lb. per sq. in., which can be changed over quickly into a gas engine to operate at 350-lb. per sq. in. internal pressure using the Otto principle and electric ignition. There is today a very definite trend for engines of this type that can be altered for gas, since capacity of wood-gas generators has been raised to 1 hp. per 2.2 lb. of wood. Deutsche Werke had an interesting combination of convertible engine and coke-gas generator. The 3-cyl. engine has a capacity of 60 hp. when running on gas and 74 hp. on diesel oil.

The smallest unit (gasifier combined with gas engine) was a Deutz 5-hp. engine, well designed and very suitable where wood is plentiful. Larger portable units, with capacities up to 1,000 hp., are being used in barges and trailer vessels. Trucks with wood-gas generators are being built extensively—there are already over 2,000 on German highways, and more are coming.





TOP—M. A. N. gas engine with, at left, the new 40-hp. steam-motor, with compact boiler. ABOVE—The booth lettering reads "Power from Domestic Fuels," keynote of the power situation in Germany today. LEFT—Largest engine at the Fair was this 1500-hp., 6-cyl., M. A. N. diesel

Several firms showed supercharged diesels, equipped with exhaust-gas turbines, which have raised capacity 40% without increasing engine weight. These engines, famous for their high efficiency, are used mainly for peak loads and in vessels. The largest diesel on exhibit was a single-acting, 4-cycle,

6-cyl., 1,500-hp., 250-r.p.m. M.A.N. engine built for stationary power plants, river vessels, coastal craft and small sea-going ships.

Almost all of the diesel engines shown at Leipzig can be run either on diesel oil or synthetic fuels produced from anthracite coal or other materials. Krupp displayed a special spray valve which can safely handle thick tar oil.

The Lanova diesel produced by Hentschel and by Güldner, with air storage and preheating chamber, has complete and smokeless combustion and is practically noiseless, even at the high speed of 1,500 r.p.m. Gas engines made by the same firms differ from the diesel only in the mixing valve, magneto and other small parts, so that propane, butane and other rich gas can be used. Carburetors are provided for adapting these engines to gasoline.

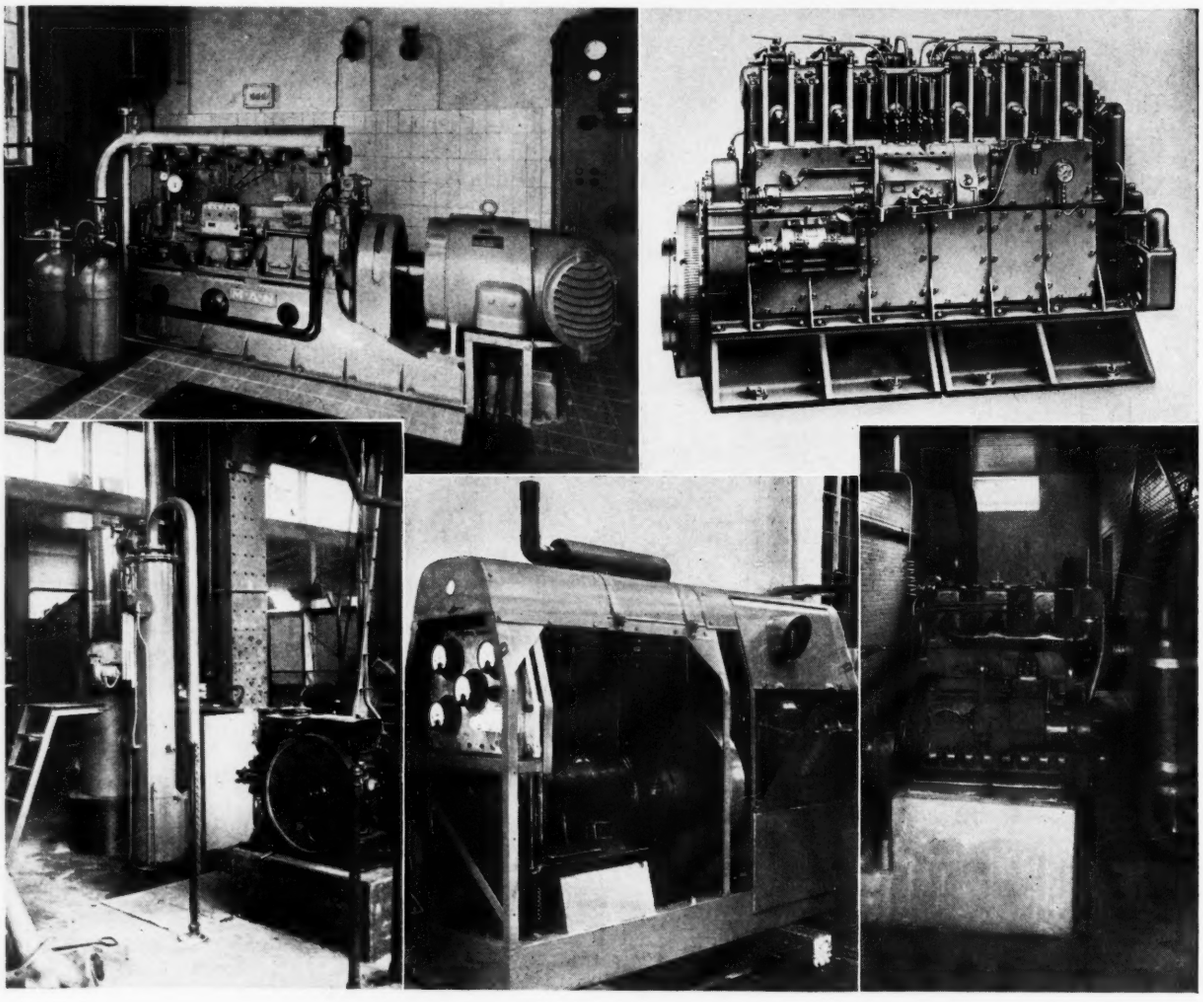
Junkers exhibited a 4-cycle engine, without piston rods and crankshaft, so vibrationless that a lead pencil stood up on end on the engine would not fall over. Several other firms, Buckau-R. Wolf, Modaag, and MWM, displayed convertible engines combined with gasifiers, small 2-cycle engines with blowers for scavenging, and 4-cycle generator sets for emergency use in hotels, hospitals, and theatres.

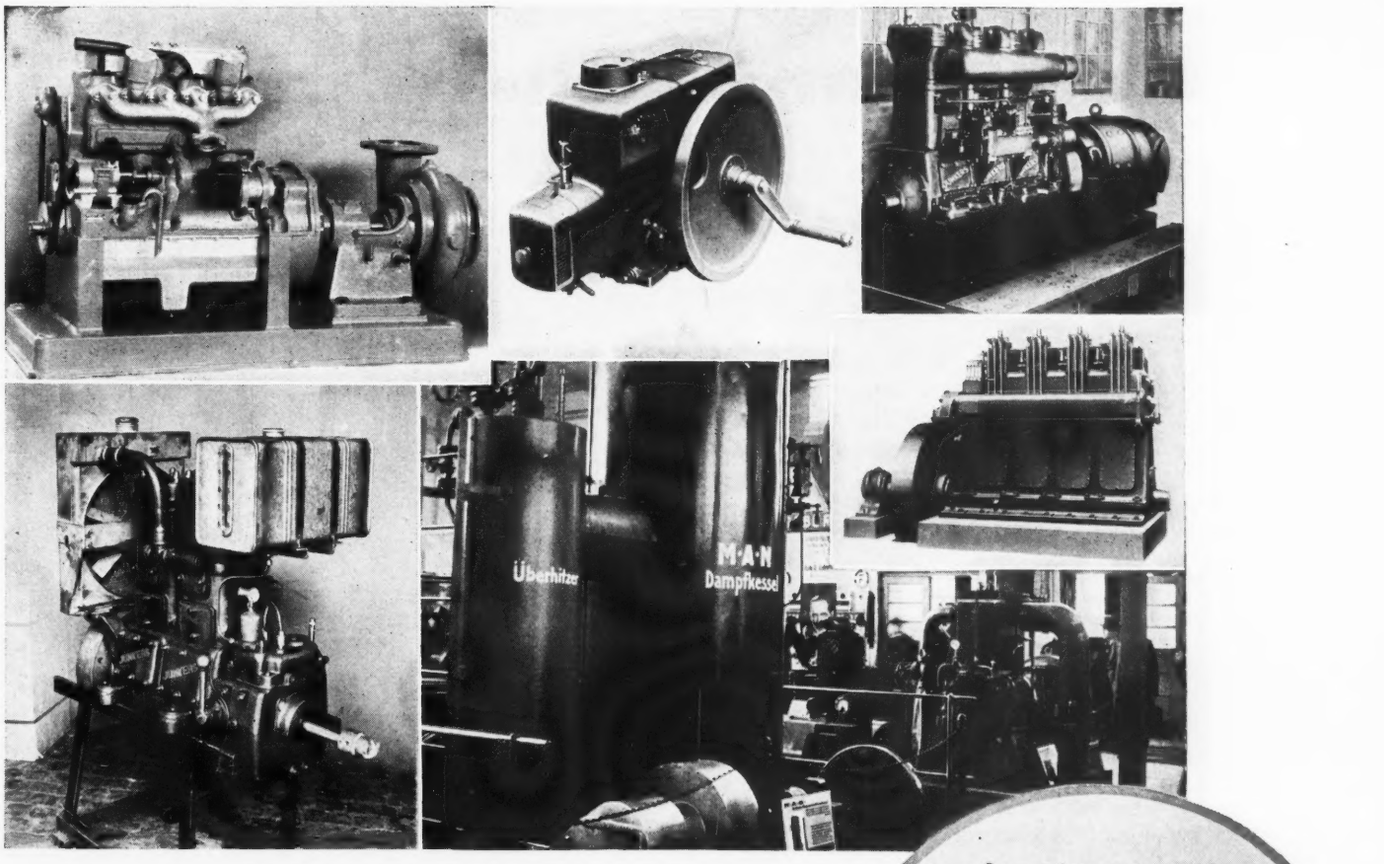
One of the most interesting exhibits at the Fair was the M.A.N. 40-hp., 1,000-r.p.m. steam-motor compactly combined with a vertical force-feed boiler, which has a maximum continuous capacity of 530 lb. of steam per hr. at 480 to 570 deg. F. and uses a lignite tar-oil fuel. The steam engine is a uniflow with steam-inlet valves and outlet ports. This machine is being built in 30- to 150-hp. sizes and is adaptable for various conditions, even for power and waste-heat supply combined.

A mechanical stoker, designed by L. Steinmueller & Co., received much comment for its simplicity. It consists of a triangular bar resting transversely on the grate beneath the coal layer. As this bar moves across the grate in intervals of 1½ to 3 min., it carries more fresh fuel to the mouth of the furnace than to the back and brings glowing coals to the front so that coal starts to burn at the mouth. Movement of the bar simultaneously evens out the coal layer, thus improving efficiency and CO_2. An important advantage of this design is that the stoker can be built into old plants having water-tube or Lancashire boilers.

Boilers with forced feedwater circulation, under the trade name of LaMont, are being used to a large extent—320 LaMont plants are in operation or under construction in Europe. A boiler of this type, exhibited by Messrs. Oschatz, has a normal steam capacity of 8,000 and a maximum of 10,000 lb. per hr. at a pressure of 210 lb. per sq. in. and 680 deg.

TOP LEFT—High-speed, 4-cycle, 6-cyl., M. A. N. diesel—generator emergency set, 150 hp. at 1500 r.p.m. BOTTOM LEFT—Deutz wood-gas producer. BOTTOM CENTER—Mercedes-Benz 20-40 hp., 2-cyl. totally enclosed diesel set. BOTTOM RIGHT—Mercedes-Benz 3 cyl., 30-55 hp. diesel driving lineshaft in mustard factory. UPPER RIGHT —6-cyl., 4-cycle, Krupp diesel delivering 100 hp. at 1000 r.p.m.





F. Feedwater is circulated by a centrifugal pump located between the water-filled and steam-filled parts of the steam drum, thus working under boiler pressure. Quantity of circulating water is eight times as much as the boiler's evaporating capacity.

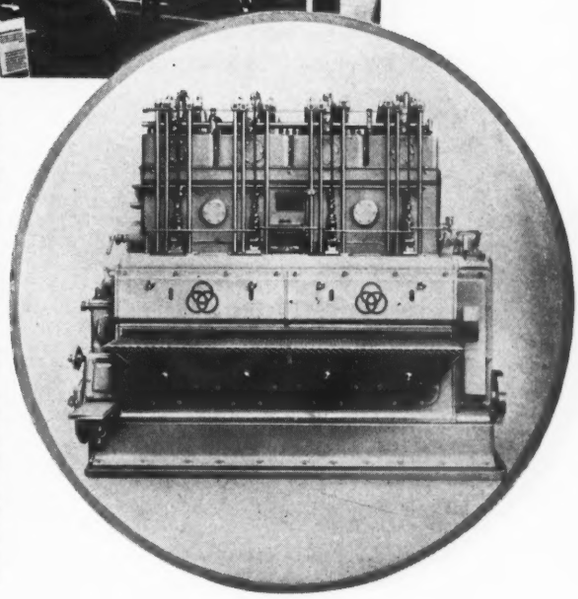
The LaMont boiler exhibited was remarkable for its smallness, being 8 ft. 6 in. wide, 13 ft. 8 in. long, and less than 13 ft. high. An important part of this boiler is the evaporator-tube nozzle, the aperture of which is accurately calculated according to the steam pressure produced in each tube. By this arrangement, a specialty shown by Liesen & Co., each tube is fed only with the amount of water necessary for efficient cooling and for preventing burn-outs.

Economizers and Control

In America and England, almost all economizers are of the smooth-tube type, but in Germany, manufacturers supply almost exclusively the fin-tube type with short and broad ribs. Messrs. Hartmann and the Vereinigte Economizer Works showed such economizers with streamlined tubes said to have even greater efficiency than the long-ribbed type.

Control equipment was much in evidence—controls for boiler plants as well as for internal-combustion engines. I saw a portable Orsat apparatus made by Ados, built into a metal box with a total weight of just 10 lb.; Venturi controls; differential-pressure gages; equipment for distant reading and recording of temperature, pressure, flow of liquids, etc.; and an Oval wheel-type apparatus for measuring liquids, so improved that it actually is accurate.

Air conditioning will soon find a large field in European countries, as it now has in the United States. However, air conditioning in Germany does not mean cooling, solely heating, humidifying and cleaning. Most of the firms that exhibited, including M.A.N. and Benno Schilde, laid particular stress on humidifying and full-automatic control. Air is warmed by passing it through a grid heated by low- or high-pressure steam, hot water, gas or electricity, as shown by Nema. M.A.N. exhibited a unit of sufficient capacity for a 2,800- to 3,500-cu. ft. room. Several kinds of air filters were demonstrated, including cloth, both dry and with oil film, the latter one passing air continuously through an oil bath to remove dust immediately, spiral-wound wire and steel-strap filters. Small filters for internal-combustion engines and compressors have corrugated-steel straps as a filtering element.



TOP LEFT—4 cyl., Mercedes-Benz, 30-hp. diesel direct-connected to Sulzer low-pressure centrifugal pump. TOP RIGHT —Junkers 3-cyl., 75-hp. diesel set on spring foundation. TOP CENTER — MWM, 10-hp., hand-cranked, horizontal diesel. LOWER LEFT — Hand-started, 2-cyl., opposed-piston Junkers power unit complete with fuel tank. LOWER RIGHT — Another view of the vertical force-feed steam boiler and steam-motor. RIGHT CENTER — MWM 180-hp. Benz diesel. CIRCLE — Junkers 4-cyl., 4-cycle diesel delivering 265 hp. at 428 r.p.m. It is adaptable for use with domestic liquid fuels

Power for Exclusives

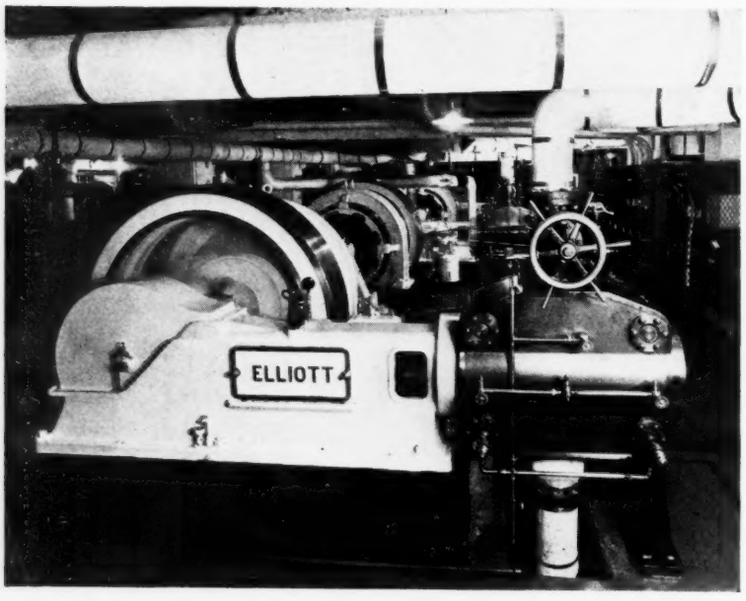
By Edwin A. Kingsley
Consulting Engineer

At the Lombardy Hotel, a new power plant meets these objectives: no objectionable noise during construction, no interruption of steam or power services, no vibration or objectionable noise from operation, no light flicker, substantial financial savings

BUILDING owners are sometimes deterred from installing private plants by fear of construction and operating noise, vibration and flickering lights. When the building is an "exclusive" hotel or apartment hotel, catering to a high-rental clientele that demands perfect service, quiet and dignity, these questions assume serious proportions. Actually, there seldom is any good reason for such apprehension if the plant is properly designed and constructed, as was that in Hotel Lombardy, a 22-story hotel of 148 apartments at 111 E. 56th St., New York City, where, in November, 1936, a complete steam power plant was placed in operation.

The only noise heard by tenants — for a short time during construction — was muffled but unavoidable rock drilling for sub-cellar engine foundations, and this was not of sufficient intensity or duration to cause complaint. Plant operation has been noiseless as far as tenants are concerned. One evidence of this is that after change-over from street steam and electric services, made without the slightest interruption to either electric or steam supply, tenants knew of the change only when curiosity prompted them to inquire whether the plant had been placed in operation.

Three 100-kw. engine-generators supply power to the Lombardy



This installation has been in service for about five months, with perfect satisfaction. It has met widely fluctuating steam and electric loads, with negligible engine-room and boiler-room noise and without "flicker" in lights. Financially, the plant has produced operating economies that make liquidation of its cost out of savings certain within $3\frac{1}{2}$ years.

The general principle of design provides that either of two boilers can handle maximum steam load and any two of three generators maximum electric load. Because of this spare capacity, boilers and engine-generators may be used alternately and, therefore, are easily maintained. Even more important is the insurance spare units provide against shutdown in case a boiler or engine-generator develops trouble.

Two Union Iron Works bent-tube boilers, each containing 2,150 sq.ft. of heating surface and designed for 200% rating, deliver saturated steam to engine throttles at 150 lb. pressure. Each boiler has two Petroleum Heat & Power Co. burners which use No. 6 (Bunker C) fuel oil. One burner or both may be used, according to steam demand and judgment of the operator. Approximate oil consumption is 1 gal. per 110 lb. of steam generated.

Control

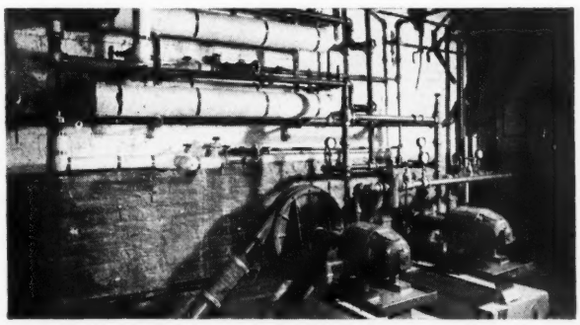
Steam pressure is closely maintained at a predetermined point by a Ruggles-Klingemann control on each boiler, actuated by city water. These control quantity of fuel oil and primary air passing through the burner "guns" and secondary air entering the furnace through movable radial louvres that surround the burner.

In the boiler room are duplicate Petro fuel-oil pumps and blowers, oil preheaters and various fuel-oil auxiliary devices. In an adjoining room there is a 13,000-gal. closed, welded-steel storage tank, which holds the main fuel supply. The tank is filled from street curb and vented above street level.

The smoke breeching in the boiler room is provided with a barometric damper which controls draft and CO_2 by permitting more or less boiler-room air to enter the breeching, and incidentally, provides boiler-room ventilation.

Air supply demanded by the oil burners, instead of being brought from outside the building to burners by the shortest possible route, is conducted to the far end of a solid floor gallery adjacent and open to the boiler room. From this point it flows to the boiler room proper and descends to the burners. Prior to plant installation, gallery temperature was uncomfortably high due to steam-distribution manifolds, valves, hot-water tanks, etc. Now, with the area traversed by relatively cool street air, room temperature is considerably lower. Operation of the burners and barometric damper has produced air circulation which results in a comfortable boiler room.

Adjoining the boiler room is the engine room, in which were installed three engine-generators and the switchboard. Two are Elliott 4-valve uniflows and one an Elliott single-valve, each driving a 100-kw., 120-240-volt d. c. generator. The single-valve



Fuel oil pumps and primary air blowers are combined in a single set. Oil heaters are on the wall

engine, because of its greater steam consumption, is used whenever demand for exhaust steam is high; at other times it is held in reserve as the "spare" or standby unit.

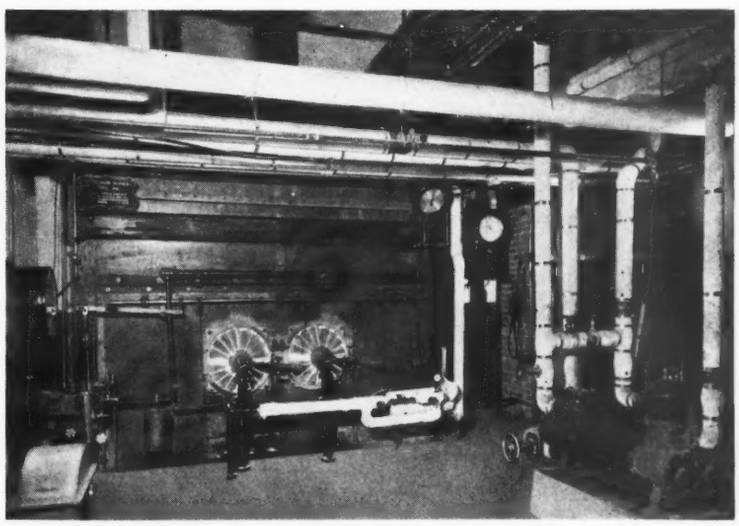
Exhaust steam supplies heat and heats water for the hotel and adjacent apartment houses, various kitchen devices and, of course, heats the boiler feedwater. Excess exhaust steam is discharged into the brick stack. The importance of using exhaust steam is emphasized by the fact that before the plant was installed the hotel alone purchased from the street service, annually, about 17,000,000 lb. of high-pressure steam and reduced it to low pressure for various uses in the building.

It will be noted from the engine photograph that there are no steam separators at the engines. Due to low headroom, individual separators were abandoned in favor of one large separator unit in the boiler room at a point where the main steam line passes through the engine-room wall. This is giving complete satisfaction.

Engine-generator units are set on concrete foundations which rest on cork pads and are provided with cork isolation on sides and ends. Foundation pits are concrete with integral waterproofing. They were sealed with a waterproof membrane on bottom and sides before the cork isolation was placed in position. A second waterproof membrane was then placed over the cork on bottom and sides, and the foundation block poured. Foundations of two units are in one mass. Because removal of certain existing equipment was inexpedient, the foundation of the third unit could not be made integral. However, in both cases results are satisfactory, there being only a negligible amount of vibration in the foundation blocks themselves and none whatever in the surrounding pit walls or engine-room floor.

Fresh-air ventilation of the engine room is provided by an adjustable-speed blower connected to a duct which runs from the side of the building, above street level, to a plenum chamber in the ceiling over the engine-generators. The chamber is equipped with adjustable outlet louvres through which air is discharged into the engine room at whatever rate produces most comfortable conditions for the operating personnel. Ventilation is intended primarily for summer use. As the plant has operated only in cold weather, engine-room conditions have been comfortable without the forced-ventilation system, due in part to the extra circulation induced by the oil burner and barometric-damper air demands in the boiler room.

So that the hotel owners may accurately compute monthly financial savings effected by the plant, the switchboard is equipped with watthour meters and



Steam for power, heating and kitchen service are supplied by these two boilers

a kilowatt "demand" meter, and all low-pressure steam returns are piped to a condensate meter. These establish, in kilowatt-hours, kilowatts of "demand" and pounds of condensed steam, the basis for calculating what similar quantities of electricity and steam would have cost had they been purchased from street services instead of having been generated by the plant.

[The entire plant was designed by Edwin A. Kingsley, consulting engineer and installed by the Petroleum Heat & Power Company, Inc., of New York City. Percival Robert Moses, Sidney R. Klein & Associates, consulting engineers, were the reviewing and supervising engineers for Huberth & Huberth, managing agents for the owners. William Wakem is chief engineer —*Editor*]

I'm Raising My Boy to be an Engineer

MY BOY wants to be a power engineer. I am one, but I still learn in helping my son. My wife taught him elementary reading and writing. Later, I engaged a university M.A. to teach him three hours daily. After several months, however, this scholar had force-fed him in arithmetic so that the boy was developing a hatred for what should be the engineer's best friend and handiest tool.

So I took the matter in hand myself, and now we learn arithmetic only where he requires it. Almost any boy likes machinery, so I make use of this fact. For instance, I got him interested in machinery catalogs. A machine and its parts from foreign countries involve duties, sales taxes, discounts, etc. We learned together the decimal system for computing these. While I am absent at the power house, this boy sits down and computes what a certain piece of machinery will cost erected in our shop.

We purchased for him the best micrometer money could buy, to learn its practical use and, of course, the mathematics behind it. He became so interested that he forgot he was learning something, and in no time had mastered its use. He finds problems involving multiplication and long division a little irksome, and that at once suggested a "guess stick" or "mathematical trombone." At my suggestion, he wrote away for pamphlets describing different slide rules, and he eventually ordered a 10-in. rule. This gave me the opening to explain common logarithms. Afterwards, we made a paper slide rule, and the whole idea went over with little mental anguish.

Beyond the "Parrot" Method

Of course, I did not neglect to mention another type of logarithm, which is not to the base 10, but which the expansion of steam follows. We will, however, take this up later when the stage is set for its practical application in steam. I remember in my own case several hundred propositions in Euclid being force-fed by the memory route in much the same way you would teach your pet parrot to swear. I am trying to go beyond this method.

The fundamentals of power factor are being mastered in their application to the power-factor meter on the switchboard. We spend an hour daily together in practical electrical study. When I am away at work in the daytime, or sleeping after a night shift, the boy spends the time journeying over the world on short- or long-wave radio, and reading popular or modern mechanics magazines. He has real tools—all the best I can afford, and every possible encouragement to use them. We both look forward to the time when we can buy as many power tools as possible for our shop.

He sent 25 cents to a firm in the Middle West for a book, "How to Operate a Lathe." To my delight, he spent much time on the book when I

was absent at work. When he wrote for lathe catalogs, the firm replied that a salesmen in a nearby city would call. A few days later, this man called and asked for Mr. Blank. "Yes," the boy answered, "I am Mr. Blank." The super-salesman laughed and walked away. Had he, however, taken the trouble to talk lathes to the boy, I think the laugh would have disappeared quickly. The boy would have brought him to me at the power house, and we would have purchased a small lathe we wanted.

The plant where I work is beside the sea, with a deep-sea loading dock within a stone's throw of our house. Here many freighters load cargo for all parts of the world, and many sea-going tugs, mostly steam-driven, come from other ports. This gives us the opportunity to look over many fine engine rooms, both steam and diesel.

We have purchased a sea skiff with a second-hand, 12-hp. outboard motor, which you operate by being not only an engineer, but a marine cowboy as well. The starting rope is the only part of outboard engineering that has ever bothered the boy, and now he has outgrown it. He is really a better trouble shooter than I am. Last year I picked up a 25-ft. sailboat, originally built in China. The local bank manager helped us finance the importation of a marine motor with built-in starter and gearbox. When my boy has mastered this power plant, I want to get a diesel if I can afford it. And when my son becomes 16, I want, if possible, to apprentice him into a shop that builds steam turbines.

This may be an expensive way, both in time and money, to educate and train a boy, but my son is my most cherished possession, although, in some instances, unintentionally the most neglected. Even today, our learning together is paying big dividends in the bond between us. Perhaps some day he may prove a competent nurse-maid for the magnificent prime movers that science is developing for us.

PRACTICAL AIDS TO OPERATION

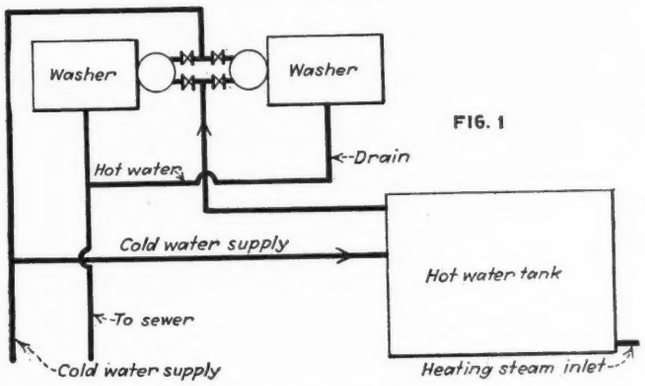


FIG. 1

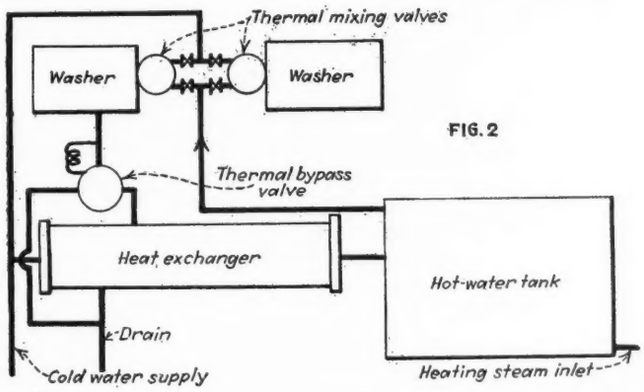


FIG. 2

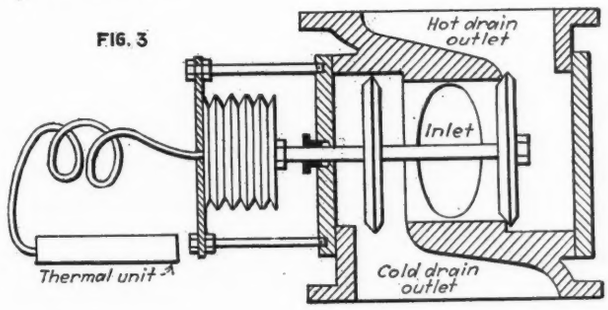


FIG. 3

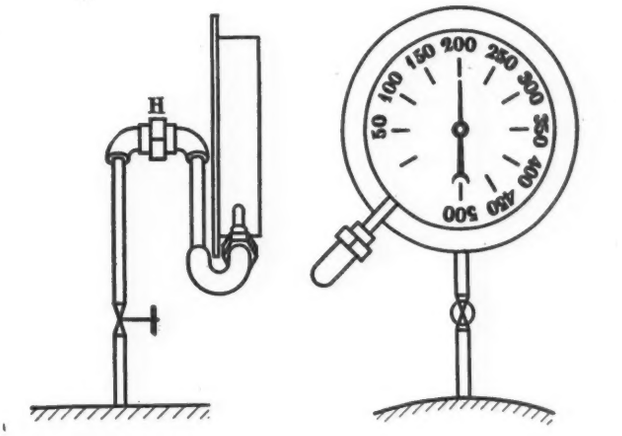
Recovering Heat From Hot Waste Water

IN LAUNDRIES, much heat is lost in waste hot water that runs to the sewer. If only a part of this heat were recovered, large savings in fuel would result. Fig. 1 is a diagram of two washers to which water is supplied through cold and hot-water lines. These lines join in thermal mixing valves that control water temperature to the washers. When the washing operation is completed, hot wash water is drained directly into the sewer.

If, instead of allowing water to run to the sewer, it is first passed through a heat exchanger, as in Fig. 2, part of the heat can be saved. The thermal valve in Fig. 2 is shown in detail, Fig. 3. This valve is operated by a gas thermal unit placed in the drain pipe. When cold water flows from the washer, the valve is in the position shown and water flows into the inlet and to the cold-water drain without going through the heat exchanger. Hot water flowing from the washer causes the thermal unit to expand, which shuts off cold water and opens the valve to the hot-water outlet leading to the heat exchanger.

When waste-water flow does not synchronize with cold water flowing to the heating tank or when it is desirable to dump the washers quickly, a tank installed between the thermal bypass valve and the heat exchanger will solve the problem. Hot waste water can be stored in this tank and allowed to run through the heat exchanger and to the sewer at will.

Brooklyn, N. Y. CLAUS LEVINSEN



Vertical Gage Pointer Aids in Reading Pressure

DEVISED FIRST to aid a Negro fireman in reading the pressure of boilers furnishing steam for a southern sash and door mill, the kink shown in the diagram has since been adapted to oil-well boilers to simplify reading pressure under widely varying conditions of visibility. A standard gage is mounted on the usual stub or pipe nipple with a standard shutoff valve or cock as near as possible to the boiler shell. Instead of being mounted directly above this stub, the gage is joined to the line with a U-bend and two unions.

By cutting nipples to the right length, the short horizontal-run *H* comes exactly behind the center of the gage dial, on an extension of a line through the gage-hand pivot. The gage may be turned, by loosening the union at *H*, so that the normal reading will be vertical, as in the figure. Once installed, checking of pressure becomes semi-automatic, as angle of vision makes the gage-hand position easily noted even though figures on the dial are unreadable.

Longview, Texas ELTON STERRETT

Hot-Water Storage Saves $4,000 per Year

HOW A fluctuating steam load can be simply and inexpensively smoothed out with a resultant saving in fuel and reduction in maintenance cost is always of interest. This particular plant used about 36,000 gal. of water per 12-hr. day at a temperature of 140 deg. F., supplied by a 2,000-gal. heater that could deliver 8,000

gal. of water per hour, when heated with 100-lb. steam. Steam load was handled easily in the summer by a 2,000-sq.ft. boiler, fired with pulverized coal. In winter, 40-deg. cold water and steam for building heating made it difficult for the boiler to carry the load.

Hot-water demand amounted to 3,000 gal. during a ½-hr. period each hour, which required water to be supplied at a rate of 6,000 gal. per hr. during that period. 2,500 lb. of steam or the equivalent of 5,000 lb. per hr. were used in heating this water. In addition, for other heating purposes, 9,000 lb. of steam per hr. were required in winter months. This made it necessary to operate the boiler at ratings varying from 150 to 230% normal capacity. These conditions caused operating difficulties with both furnace and the coal-pulverizing equipment and required burning expensive coal.

The company was considering the purchase of another boiler when I was called in to survey the plant and make recommendations. The survey showed a low night load, and it was suggested that water be heated at night and stored in a 20,000-gal. wooden tank that was available. To keep heat loss to a minimum, the tank was insulated, and in order to store as much heat as possible, water was heated to 180 deg. and a mixing valve installed to supply 140-deg. water to process. Heating the water to 180 deg. gave the 20,000-gal. tank an equivalent capacity of about 24,000 gal. at 140 deg.

Now the 2,000-gal. heater, instead of supplying hot water directly to process, feeds into the 20,000-gal. storage tank. During the day, the heating-tank thermostat is removed and the steam valve cracked to feed continuously at a given slow rate the amount of water necessary in excess of the 24,000 gal. available for daytime operation. After the day's run, the almost empty tank is filled with cold water, which is heated during the night to the desired temperature.

Reduction in boiler load during the day made it possible to use a low-cost western bituminous coal. Furnace troubles were practically eliminated, and pulverizing-equipment maintenance became normal. The saving in coal cost amounted to about $4,000 per yr. compared to approximately $800 for rehabilitating the tank and purchasing necessary equipment.

Chicago, Ill. ZUCE KOGAN,
Consulting Engineer

Why H. R. T.-Boiler Braces Bow

HORIZONTAL return-tubular boilers are usually provided with two braces below the tubes. These braces pass through the front tube sheet, and are made tight by nuts and washers inside and out. At the rear ends, braces are spaced and riveted to the tube sheet. Angle irons or riveted plates are used, placed to allow water to circulate between them and the tube sheet. If this were not done, double thickness of metal might cause overheating in this high-temperature zone.

Not infrequently on opening a boiler of this type, one or both of the braces is found bowed. Bow direction is usually, but not always, upwards, as in the diagram. Causes of bowing are a subject of much controversy, and have been the source of questions asked in engineers' examinations, even though the examiners have not agreed on the correct answer. However, the writer has compiled answers to this question from a score of engineers, boiler inspectors, and others who have investigated conditions present when bowing of braces was discovered.

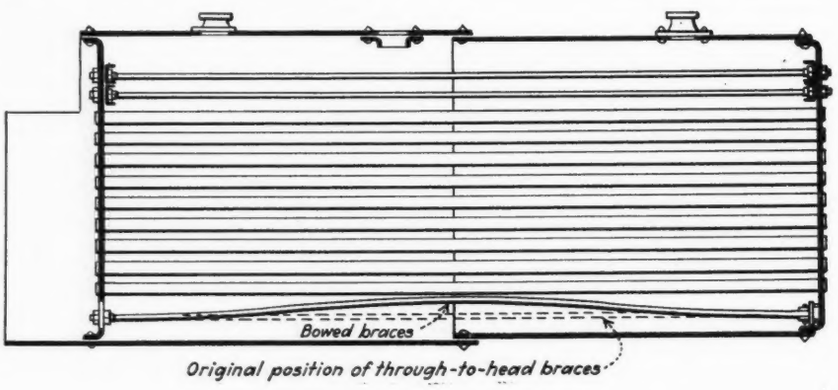
Possibility of a brace being bowed by faulty installation is acknowledged, but is not considered in this article. A broad answer to the cause of bowed braces is overheating. Braces give support to the flat segments of the two tube sheets below the tubes, and are under moderate tension, say 9,000 lb. per sq.in., when the boiler is operating at full pressure under normal conditions. This stress is within permitted design limits, as the A.S.M.E. Code allows 10,400 lb. per sq.in. on this type of brace when it is over 1.5 in. in diameter and when its length between supports does not exceed 120 diameters.

An increase in boiler pressure beyond permitted limits will increase this stress, but there are other more common causes. A coating of scale, sludge, or oil on the boiler-shell bottom will insulate the plate from the cooling effect of water, and cause shell-plate temperature to rise. We may assume that temperature does not rise enough to cause a serious accident, but nevertheless, there is a considerable increase. If the boiler is 18 ft. long, it will tend to expand 0.0014 in. for each degree F. of rise. Braces resist this expansion and are subjected to an increased tensile stress. Tubes resist it also, but as they are farther away from the shell, they are not often seriously affected. In extreme cases, tubes may break their expanded seats and leak.

Stress on braces usually exceeds their elastic limit, permanently elongating them and the shell usually bulges. It should be remembered that while the shell is expanding from the increase in temperature, temperature of the braces does not increase, assuming constant boiler pressure. They are surrounded by boiler water and are not affected thermally by external conditions. When the boiler cools, the shell will contract and compress the permanently elongated braces, bowing them between their supports.

It may be difficult to understand how one part of a boiler shell (the bottom) can expand more than some upper part when a boiler is considered a rigid, immovable object. Actually, this difference in expansion does occur, and is the cause of expansive stresses throughout the boiler.

Flushing, N. Y. HARRY M. SPRING



Obtaining Good Commutator Performance

CARE of d.c.-motor and -generator commutators is a highly debatable subject. Almost every maintenance engineer has his own pet methods which he is prepared to defend against all others. The following suggestions are presented as experience with many thousands of machines.

In practically all cases, machines should be put into service in the condition they are received from the manufacturer. They have been thoroughly tested, brushes well bedded to fit the commutator, which is finished as perfectly as possible without long-time running. Commutator and brushes should be watched during the first six months' service. During this period, the commutator is being polished by the brushes, and is, or ought to be, taking on a glossy chocolate-brown appearance, which promotes long wear.

Unless burning or roughness appears, a commutator should not be touched with a grinder or sandpaper. Insufficient or excessive brush pressure, high mica, overloading, belt whipping, faulty gears, vibration of machine on which the motor is mounted, or unequally-bedded brush surface should be looked for and corrected. If roughness develops, as it may on the best commutators because mica seasons under operation, from flashing caused by excessive starting load, heavy dynamic-braking or overload current, it should be removed by fine sandpaper. If sandpaper will not remove the roughness, a commutator stone may be used. Where this fails, the only remedy is to turn the commutator in a lathe or use a portable grinding tool.

If, because of chattering brushes or other reasons, commutator lubrication appears necessary, a small amount of paraffine wax may be used. When a commutator is first manufactured, its surface is covered with microscopic ridges that are removed by wear during actual running over a long period. While the action of paraffine on a commutator has not been definitely proven, it apparently fills in the minute valleys between ridges and thus tends to prevent excessive brush wear. If paraffine is used, it should be applied by putting it on a piece of canvas in a quantity to cause barely perceptible stiffening of the fabric. After applying paraffine to a commutator, it should be wiped immediately and thoroughly with a clean piece of canvas.

Most modern commutators have the mica cut below the copper bars to prevent it from extruding high enough to cause poor contact and sparking. I favor a V-type cutter which removes enough of the adjacent copper edges from the bars to form a small bevel above the mica at the slot edges. For best results, slots of this type may be cut shallower than U-type slots. I hold no brief against U-slots, except in the case of motors operating in dirty places where they may collect dirt and dust and form a short-circuit between bars. V-slots, being shallower and wider at the top, are more likely to throw out dirt than the U-type.

On some motors, it is not desirable to use a V-slot, particularly on very small machines, where the commutator is so small that V-slotting produces what is practically a number of rather flat places. These are apt to cause the brushes to jump and spark, and a U-slot is therefore preferable.

In spite of the many motors that have operated satisfactorily with mica and commutator surface flush, it is inadvisable to follow this practice on general-purpose motors. After a new motor goes into service, seasoning and extrusion of mica continues for quite a time, and if flush micas are used, it is usually necessary to use abrasive brushes for a period to wear them down.

Cleveland, O. L. E. MILLER,
Reliance Electric & Engineering Co.

Automatic Acid Feeder for Boiler Feedwater

WHEN sulphuric acid is added to boiler feedwater to reduce alkalinity, close control is essential. We use the device shown below to feed acid practically in proportion to water feed.

Acid solution flows from the 50-gal. head tank *A* to the constant-head tank *B*, Fig. 2. Both are lead lined. Solution level in *B* is kept constant by a float valve, constructed of a milk bottle, rubber stopper, glass rod, rubber plug valve and glass-tube guides, Fig. 1. Syphon line carrying acid from *A* to plug valve of *B* is made of glass and rubber tubing.

A similar glass and rubber tube syphons the acid solution from the constant-head tank to the steel mixing tank, *C*. This syphon terminates in a glass jet (3/64 in. orifice), floated on a block of wood to rise and fall with the level of water in the mixing tank.

Water level in tank *C* lowers as demand of feed pumps increases. This lowers syphon float and increases acid flow in approximate proportion to water flow. Jet diameter of 3/64 in. was determined by experiment. This equipment maintains the necessary sulphate-carbonate ratio, and reduces alkalinity from 100 p.p.m. to between 52 and 62 p.p.m.

Hibbing, Minn. ABE BENESOVITZ

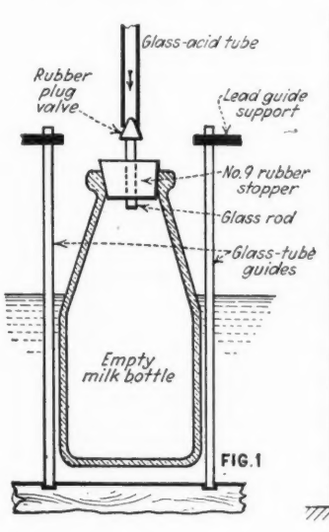


FIG. 1

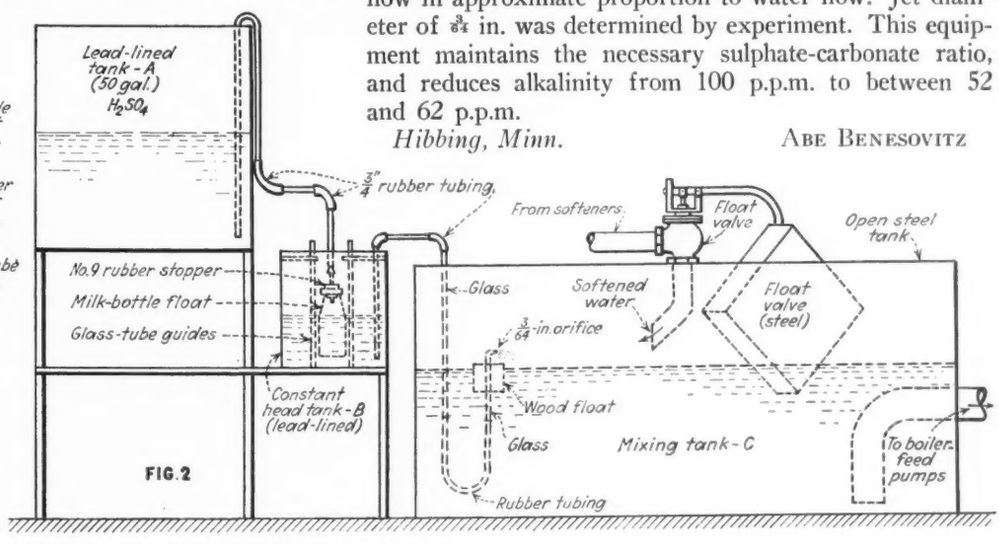


FIG. 2

CURRENT COMMENT

Invites Discussion on Smoke Prevention

I INVITE discussion on the following newspaper item, clipped from a recent Salt Lake City newspaper:

"Two experiments to reduce smoke in Salt Lake City were receiving support Saturday from the chamber of commerce smokeless city committee.

"One, suggested by Jerome Amussen, heating engineer, would "burn" volatile gas of smoke by means of a gas jet in the chimney breech. Use of such an apparatus would be necessary only at times when plants would be prone to smoke, such as early in the morning when firemen are attempting to get up steam in a hurry or when they remove clinkers.

"The second would require that coal be pretreated with a catalytic agent. Coal thus treated now is being burned in the city and county building heating plant to determine effectiveness of the method, said Arthur McFarlane, committee chairman.

"The committee authorized McFarlane to appoint a subcommittee to wait on the city commission asking for appointment of a successor to Julius Billeter, smoke inspector, resigned, and for an appropriation for smoke inspection."

I disapprove of placing a gas jet in the chimney breeching. If it is to be used at all, why not place the gas jet just over the grates or bridge wall and use heat from both gas jet and burning hydrocarbons?

Salt Lake City, Utah S. T. STUART

Tension in Guy Wire

THE *down guy from the guy stub at the end of a pole line makes an angle of 45 deg. with the ground. How does tension in the down guy compare with that in the horizontal overhead guy?* —R.M.

If down guy is attached to pole at level of the overhead guy, tension in down guy equals product of tension in overhead guy multiplied by $\sqrt{2}$ or 1.41. In short, the down guy carries 41% more load. Sketches show how this and similar problems are solved.

Fig. 1 illustrates the general principle that if several forces acting on any point of a structure are in balance, the polygon of forces will "close". To draw a force polygon, place the force arrows end to end in any order with the heads running in the same direction. Each force arrow (vector) must have same length and direction as at the point considered.

In the example shown, all forces are known and *A*, *B*, *C* and *D* of the force polygon are equal to and parallel to the respective forces acting at point *P*. The end of *D* falls at the start of *A* proves that the forces shown balance.

When applying this principle, remember that forces on any *fixed* point must always balance. Remember also that a wire or rope always *pulls* away from the point but that a solid member may either pull or push. A common-sense observation will

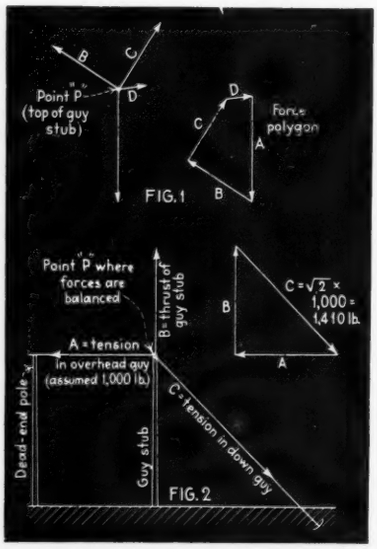


Fig. 1—Balancing forces and corresponding force polygon. Fig. 2—Guy-wire solution.

generally tell which. To find unknown forces at a point, first draw all known forces. Then draw the *directions* of the unknown forces, if they (the directions) are known. Next draw polygon, starting with the known forces. Make the polygon close and it will give you the unknown force or forces.

Fig. 2 shows how this principle is applied to your guy-wire problem. Here there are only 3 forces, so the force polygon is a triangle. Overhead guy pulls straight left on point *P*. Assume that the pull is 1,000 lb. Neglecting any bracing effect due to seating of guy stub in ground, the stub pushes straight up on *P* an unknown amount *B*. The down guy pulls with an unknown force *C* directed 45 deg. down from the horizontal. We then know force *A* complete and *directions* of *B* and *C*.

The force triangle (Fig. 2 right) is the only one possible with given forces and directions. *B* and *C* could be scaled, but the 45 deg. right triangle is easier to solve directly. Obviously $b = a = 1{,}000$ lb. The hypothenuse of a right triangle equals the square root of the sum of the squares of the two legs. Therefore, the tension *C* in the down guy is $=$

$$\sqrt{(1{,}000)^2 + (1{,}000)^2} = 1{,}000 \times \sqrt{2}$$

$1{,}000 \times 1.41 = 1410$ lb., which is 41% more than the tension in the overhead guy.

Why Bite the Hand That's Feeding You?

I HAVE read with interest and considerable conjecture the letter in January *Power* by Mr. Jones of West Haven, Conn., entitled "Why bite the hand that is feeding you?"

The first remarkable statement was the saving of 5 tons of coal per day at $6.50 a ton, amounting to $32.50 per day. Based on a 5-day week, this saving would amount to about $8,000 per year or a 6% return on an investment of about $130,000 and this saving was made at the expense of "half a day's time for a carpenter and a day's time for a mason."

The amount of fuel saved indicates that the plant is of fair size and the fact that it was only 4 yr. old and "worn out" leads to the conclusion that previous operating talent was not of the best, since Mr. Jones had no difficulty in securing the cooperation of management when possible savings were pointed out.

Repeatedly rising in the writer's mind is the question why it took 2 yr. to find a hole through which $32.50 per day of the concern's money was trickling away and why it required the assistant manager's permission to spend a few dollars in order to save $8,000 a year. Most concerns expect and are willing to pay fairly for service rendered when the value of such service is established.

Men with confidence in their ability to produce results do not long remain in a position where their efforts are not appreciated and rewarded, but of their own initiative will gravitate to positions unaffected by slack times which result in layoff.

Plymouth, Mass. C. B. HUDSON

What's Wrong With This Picture?—XIII

SINCE the feedwater regulator shown on page 167, March *Power*, under the caption, "What's Wrong With This Picture," is apparently a Copes, we would like to take some exceptions to the answers appearing on page 168.

Answer 4 is technically correct and, probably, better operating practice. However, it is interesting to note that the Copes regulator is designed so that the weight opens the valve. In case of any failure between thermostat and valve, the latter is opened wide. There have been many successful installations without the by-pass, although we recommend it, as you have.

Answer 7 is incomplete. As you say, the tube is improperly placed. However, for pressures not to exceed 250 lb. gage, center line of the tube should be 1 in. below normal boiler-water level. For pressures of 250 to 400 lb., it should be 2 in. below, and for all higher pressures, 3 in. below. In addition, slope of the tube is too great for normal installations. It should be 8 in. in the total length of 6 ft., but the drawing indicates a slope of slightly more than 24 in.

Answer 9 is correct, but incomplete. The water-connection line should drop 6 to 10 in. immediately after leaving the boiler drum. It should also drop straight down from the lower end of the thermostat far enough to permit a horizontal run of pipe to complete the connection. Answer 10 might be amplified to say that the valve in the steam line should be placed in the vertical run of pipe, preferably near the boiler.

We would also like to point out several errors not mentioned in your list. The steam line to the thermostat should preferably be covered with lagging. A blow-off line for the thermostat should be connected to the water line at a low point in the piping, and a suitable valve provided. A tension relief, furnished as part of the regulator, should be installed in the strut connection between thermostat lever and valve lever, preferably attached directly to the valve lever.

Erie, Pa. DON ALLSHOUSE
Northern Equipment Co.

Does Trepanning Discover Welding Defects?

A SHORT article entitled "A Plug Tells the Story," appearing on page 589, November *Power*, describes a process accomplished by a cylindrical saw enclosing a pilot drill. A disk is cut out of a welded seam with the saw for the purpose of etching and investigating the appearance of the removed welded section. It is intended that lack of fusion, or slag inclusions, will be found by this method.

Examination of a single hole in a long weld would not be very enlightening upon the weld as a whole. Again, if a disk was trepanned for every unit section of four or five ft., it would still be very possible for a localized defect, affecting several inches of the seam, to pass undiscovered. Local defects often constitute a dangerous condition, and the trepanned disk or plug at some distance from the defect might be a misleading indication.

A further comment on this procedure may be emphasized by referring to paragraph P-105c of the A.S.M.E. Boiler Code, reading in part: "No unreinforced hole shall be located in a welded joint." The Unfired Pressure-Vessel Code of the A.S.M.E. is silent on this point, but it might easily be concluded that, in as much as the Boiler Code does not sanction a hole in a welded seam of a type where every safeguard has been included to assure complete fusion, a hole in a weld that had not been so closely scrutinized would not be sanctioned.

If a local defect in a weld exists, but is not apparent on the surface, just how does one determine where to trepan in order to discover this defect?

Flushing, N. Y. HARRY M. SPRING

Controlling Temperature on Feedwater Heaters

REFERRING to Question 1, page 47, January *Power*, it seems that the deaerator is working under conditions very different from those for which it was designed. Design figure for water-outlet temperature is not given, but best deaeration results are obtained from 120 to 140 deg. F., so that temperature rise of water passing through the heater is probably from 60 to 80 deg.

Assuming that the actual quantity of water being handled and quantity of steam supplied are approximately normal, then the temperature at which water leaves the deaerator is about 190 + 60 = 250 deg. This corresponds to a working pressure inside the deaerator of 30 lb. per sq.in. abs., or 15 lb. above atmosphere. The vent condenser is normally kept below atmospheric pressure by the escape pipe, and if the pipe connecting deaerator to vent condenser is too large, more vapor will pass into the latter than it is capable of handling. Surplus vapor will then escape to atmosphere.

I do not advise restricting passage of vapor in the vent pipe, for this raises pressure in the vent condenser above designed rating. A better method is to place a valve in the pipe connecting deaerator and vent condenser, controlled so that a minimum amount of vapor is removed consistent with good deaeration. An orifice plate or nozzle may be substituted for the valve, and although proper bore of this plate will have to be determined by experiment, it has the advantage that once fitted, no further setting is required, and is recommended if load fluctuations are not excessive.

Temperature of water leaving the deaerator is best controlled by a thermostatic apparatus operating from the makeup steam valve. The bulb should be placed in the main condensate pipe on the discharge side of the deaerator extraction pump, so situated that it will be well covered with water under all conditions of load and never located, even partially, in any place where a pocket of stagnant water is liable to form.

Somerset, England C. B. ROBINSON

What's Wrong With This Picture?—X

IN CONNECTION with the open-heater sketch appearing in December *Power*, the following additional items might have been incorporated among the errors listed:

1. Line to the back-pressure valve should be carried up high enough so that the heating system can be taken from this line, and after these connections are made, the back-pressure valve should be installed.
2. The feedwater line should be securely anchored.
3. Generally speaking, an oil separator is part of an open-heater installation. It is good practice to have one, even though filtering material is used in the heater.
4. The heater should be insulated.
5. In order that repairs can be made on leaking pipe lines, a valve should be placed on the line from the hot well.
6. A shut-off valve should be placed on the makeup line outside the regulating valve. Also, there should be a valve on the steam-makeup line.

Buffalo, N. Y. JOHN J. TIMMONS

Laminated Oil Rings Solve Lubrication Problem

I READ with interest the article on "Grooved Oil Rings" by L. M. Tichvinsky and R. Baudry, page 726, Mid-December *Power*. I have carried on quite a few experiments with different types of oil rings, in an effort to determine cause of overheated bearings. The ring which has been found most satisfactory is one made of $\frac{3}{32}$- to $\frac{1}{8}$-in. thick sheet metal, using 4 to 6 sections per ring. Its oil carrying capacity, from observation and actual test, is greater than any other solid ring.

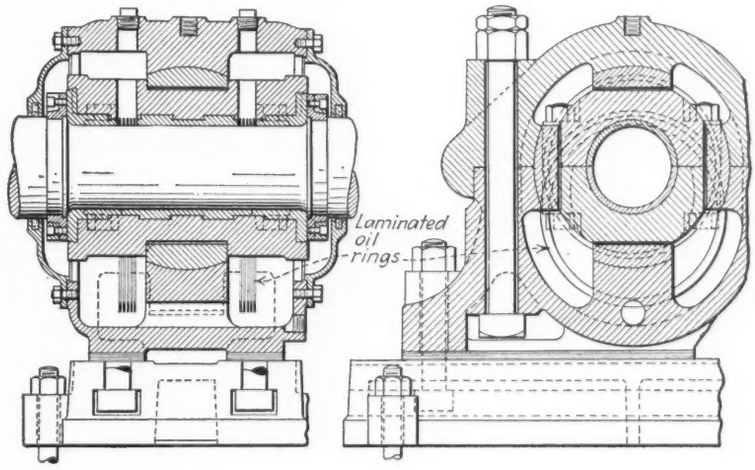
The figure shows a bearing used with the 500-r.p.m., Scharnberg heavy-duty cane shredder, which measures 10 ft. 6 in. between bearing centers and has bearings $4\frac{15}{16}$x$14\frac{3}{4}$ in. Each bearing has two 5-ring sets made of $\frac{1}{16}$-in. sheet metal. The shredder is driven by 10 V-belts and a 300-hp., 1,200-r.p.m., slip-ring motor. Running temperature of shredder bearings averages not over 20 deg. F. above that of the atmosphere.

Motor and bearings, originally designed for direct connection, were equipped with a 13-in. diameter V-pulley overhanging the bearings 15 in. Babbitt-lined motor bearings, $4\frac{7}{8}$x13 in. with cast-iron shells, were originally equipped with two tee-type, two-piece, screwed oil rings, flat of the tee running on the shaft. When operation was started, bearing temperature ran up to 180 deg. and it was necessary to blow compressed air against the oil reservoirs to keep temperature down to 150 deg.

On the next shutdown, bearings were equipped with the 5-ring sets mentioned above. Then, oil splashed violently out of the top holes directly over the oil rings, making it necessary to put a small splash plate over each hole. Oil temperature now runs around 130 deg. F., with the atmospheric temperature at 92 deg. F., and no other cooling medium is necessary.

Apparently, rings run at the same speed as the shaft, 1,160 r.p.m. During the last shutdown season, motor journals were inspected and showed no more than a polished section where rings are carried by the shaft. In operation, sectional rings are apparently driven apart when forced into the body of oil and as they come out of the oil, exposed sections are thrown together, thereby flushing the journal with oil carried on the surface of the flat rings.

Clewiston, Fla. H. J. B. SCHARNBERG
United States Sugar Corp.



READERS' PROBLEMS

QUESTIONS for Our Readers

Measuring Total Blowoff

Question 1

CAN SOME *one tell me a simple way to measure total quantity of blowoff from our boilers. The flow meters in our feedwater and boiler-outlet steam lines are not sufficiently accurate to determine this quantity by difference.*—C.W.C.

Boiler-Feed Pump Vibration

Question 2

WE HAVE *4-stage boiler-feed pumps which were designed to handle 650 g.p.m. of 300-deg. F. water when operating at 2400 r.p.m. with suction head of 209 ft. and discharge head of 1,193 ft. Head developed by the pumps was to be 984 ft.*

At first, pumps were new and ran beautifully. They were very quiet and no vibration was apparent. After a few months, the pump cover was lifted to observe whether or not scale might be accumulating on the surfaces or corrosion taking place. Everything appeared in good order so the rotor, which had been removed for inspection, was replaced after the machined surfaces of both diaphragm and pump casing had been cleaned.

When reassembly had been completed, the pump was started. It vibrated seriously above speeds of 2,150 to 2,200 r.p.m. The same thing happened to one of the other pumps, and a third started to vibrate after about three years. When it was taken apart, balance device and shaft sleeves were found badly worn and were replaced. The new parts did not stop the vibration.

Our operating conditions are not those for which the pumps were designed but are the same as the conditions under which they operated successfully for months. At 2,400 r.p.m., the discharge head is 1,035 ft. and the suction head 225 ft. The vibration persists, even though all design conditions, except temperature, are established. Can some reader tell me what is causing the trouble and what I should do to stop the vibration?—R.P.B.

Suitable answers from readers will be paid for if space is available for publication.

PIPE INSULATION

ANSWERS to March Question 1

The Question

WE *are expecting to paint all pipe coverings in our plant. Can some one tell me what sizing to use on canvas covering and what to do with bare asbestos surfaces before painting?*—E.C.

Use Fish Glue

ABOUT THE cheapest and most practical primer for canvas pipe coverings is commercial fish glue. By adding water and boiling to a thin consistency, the glue solution may be applied with a paint brush. Paint may then be applied after the glue has dried over night, or in some cases longer, as drying time of the glue is governed by temperature of the asbestos and surrounding air.

Regarding covering of bare asbestos, it has been my experience that glue should be mixed quite thin and applied in two or three coats. If the glue is too thick, it will crack and peel off.

Scottsbluff, Neb. C. A. VAN DEURSEN

Clean Canvas Covering Before Sizing

THERE ARE several preparations on the market made by well known companies that can be used to size canvas pipe coverings. Before sizing, see that the covering is clean, firmly fastened to the pipe, and that there are no joints or cracks through which heat may escape and lower efficiency of the covering. After sizing, paint the covering with two coats of lead and oil paint, the colors depending on service of the pipe.

Bare asbestos surfaces should be finished with an asbestos cement that dries hard, and it may be well to put on a canvas cover which may be sized and painted. If the asbestos is likely to be injured, it may be covered with sheet metal. On boilers, tanks and large surfaces, asbestos or magnesia blocks may be wired on, and then covered with a protective coating of wear-resisting cement.

A color scheme for the ready identification of piping systems recommended by the A.S.M.E. is given below. It is suggested that color be used only on valves, flanges, and fittings, and that piping proper be painted to conform with the color scheme of the room. High-pressure steam —white, exhaust steam—buff, l.-p. fresh water—blue, h.-p. boiler feed lines—blue and white, salt water—green, oil—black, brass or bronze yellow, fuel oil—black, air—gray, city gas (for lighting, etc.) aluminum, gas for engines—black with red flanges, refrigerating system—black pipe with alternating white and green stripes on flanges and fittings, electric lines and feeders—black pipe with alternate black and red stripes on the flanges.

New Dorp, N. Y., N. Y. C. H. HUGHES

Use Starch and Glue To Size Asbestos

PAINTING PIPE covering is always a problem. Value of the insulation depends upon the porosity of the material, and the paint tends to fill the minute openings of the material. Thus, the two work against each other. The canvas covering must be well sized. Most paint companies produce a wall primer and sealer which works very well. A good substitute can be had by mixing a strong glue solution which is particularly good for dry places.

Where asbestos covering must be exposed or cannot be covered with canvas, addition of starch will achieve results. A starch paste is made and then the glue is added. This seems to seal the outside of the covering and does not interfere with its insulating value. Use of two coats will prevent absorption of the paint.

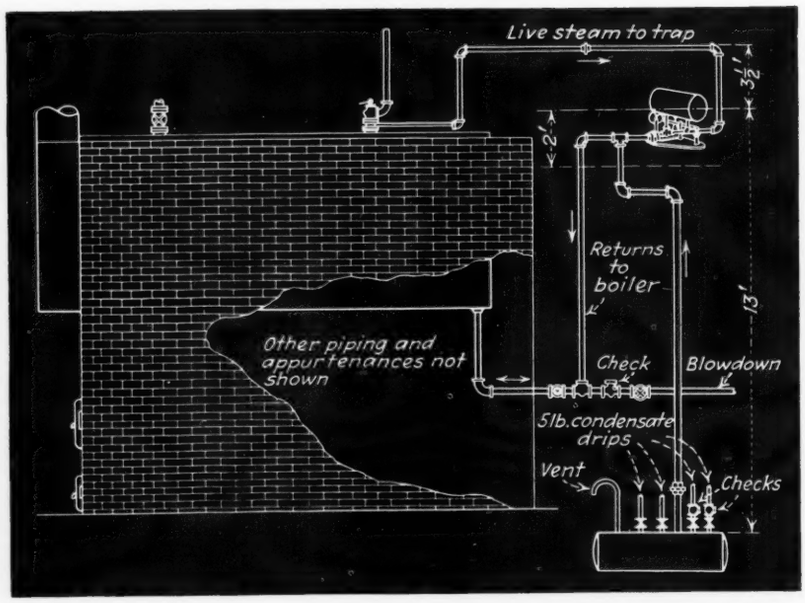
Sizing does not lower the insulating value as much as the paint does. Therefore, the use of a good sealer or two coats of glue is imperative.

Lakewood, Ohio J. P. SIMONS

WHAT'S WRONG WITH THIS PICTURE?—XV

Condensate Return System

There are at least 13 mistakes shown in this drawing. Make a list of those you recognize, then compare with the list on page 289



SUITABLE MANOMETER FLUID

ANSWERS to March Question 2

The Question

A number of manometers measure gas pressure in our plant. Pressures are so high that water can not be used as an indicating fluid and we find it hard to detect slight pressure changes with mercury. Can some reader suggest a fluid having a specific gravity 2 or 3 times that of water and suitable for use in manometers?—S. C. H.

Use Acetylene Tetrabromide

I HAVE found that acetylene tetrabromide can be used satisfactorily in a manometer where a fluid heavier than water is required. This chemical has a specific gravity of 2.97, which for all practical purposes is the specific gravity S. C. H. requires. It can be purchased from the Dow Chemical Co.

RONALD B. SMITH
Westinghouse Elec. & Mfg. Co.
South Philadelphia, Pa.

Bromoform Three Times Heavier Than Water

A SUITABLE fluid for the manometer in question is bromoform, an organic liquid commonly used for gasoline gages on automobiles. This liquid has a specific gravity three times that of water, and is readily obtainable. It is also possible to add some coloring agent to this liquid (it is water white in the pure state) and color it as desired.

It may be secured from any chemical supply house or from Merck & Co., Rahway, N. J. Another liquid which may be used, but which requires greater caution in its application, is concentrated sulphuric acid. The C.P. grade is water white and very heavy. However, it has a tendency to darken on use and to become lighter from absorption of water from surrounding gas.

Louisville, Ky. R. R. UHRMACHER

Combination of Water And Mercury

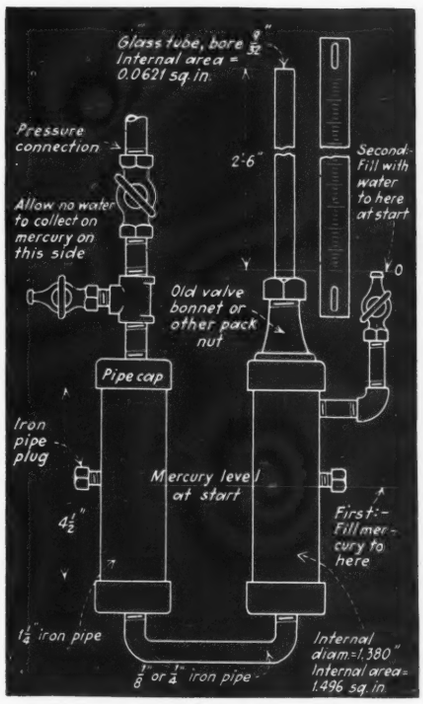
S.C.H. CAN avoid excessive expense and trouble by using water and mercury as described in the accompanying sketch. Water in the indicating tube is actuated by displacement of mercury, and the variations can be increased or decreased by using tubes of different diameters. Mercury displacement depends on pressure applied, and, with the same volume of mercury displaced, water will rise faster and higher in a smaller tube.

An experimental apparatus gave the following results on two trials:

	1st Trial	2nd Trial
Pressure, in. H_2O.....	6	6
Bulb diam., in.	$1\frac{3}{8}$	$1\frac{3}{8}$
Tube diam., in.	$\frac{9}{32}$	$\frac{1}{2}$
Rise in tube, in.	3.0	1.125
Indicated vs. actual pressure	50%	18.75%
Ratio, tube to bulb.....	24 to 1	7.56 to 1

Since the maximum pressure was not given by S.C.H., dimensions on the sketch apply to 50 in. of water or less, and some experimenting will be necessary until suitable tube size is found.

New Haven, Conn. FRANK E. FINGER


Glass tube, bore 9/32" Internal area = 0.0621 sq. in.
Pressure connection
2'-6"
Second: Fill with water to here at start
Allow no water to collect on mercury on this side
Old valve bonnet or other pack nut
Pipe cap
Iron pipe plug
Mercury level at start
First:- Fill mercury to here
4½"
1¼" iron pipe
Internal diam=1.380" Internal area= 1.496 sq. in.
⅛" or ¼" iron pipe

Suggests Using Carbon Tetrachloride

IN PITOT-TUBE measurements of water flow, usual fluids employed when water will not take care of the differential are carbon tetrachloride and bromoform. Carbon tetrachloride has a specific gravity of 1.6, which may be decreased to any specific gravity down to 1.00 by adding benzine and stirring thoroughly. Bromoform has a specific gravity of 2.75 and appears to be more suitable for the differential mentioned in the question.

Specific gravity of bromoform may be varied by adding carbon tetrachloride. Bromoform as purchased sometimes contains a small amount of alcohol, which can be removed by shaking well with water and filtering.

Madawaska, Me. EDWARD Q. WADE

Why Are Safety Valves Required on Superheaters?

SINCE 1919 *we have been operating three 1,500-sq. ft. h.r.t. boilers with attached superheaters. We have recently been ordered by the State to install safety valves on these superheaters to conform with a code effective since 1918.*

Just what is the danger that safety valves are supposed to prevent? Since the superheaters have been operated without safety valves for so long, what conditions should be investigated to see what bad effects have been produced? What determines size and relief capacity of superheater safety valves when the main safety valve has a relief capacity of 10,600 lb. of steam per hr.? If the main safety valves pop at 130 lb. pressure, at what pressure should the superheater valves be set?—T.H.R.

SAFETY VALVES are required on the discharge header of superheaters to prevent superheater-tube burnouts, which, if sufficiently extensive, may be dangerous to the boiler and to operators. Conditions that would lead to this trouble may be visualized by assuming your boilers are supplying a single turbine and operating at fairly high rating. If, due to some accident, the turbine should trip off the line, safety valves on the boiler would pop immediately, as there would be no other outlet for the steam. With no safety valves on the superheater outlet, all of the steam blowoff would go through the valves on the boiler drum, and no steam would flow through the superheater. This leaves the superheater dry, with no cooling medium, but still exposed to the hot furnace gas. Tube burnouts are the likely result.

By installing safety valves on the superheater-outlet header and setting them so they are the first valves to pop, steam flow through the superheater is always insured and tube burnouts prevented.

When there is no valve between boiler and superheater, superheater safety-valve capacity may be included in determining the number and sizes of safety valves required for a boiler. Boiler safety valves are required to have at least 75% of aggregate valve capacity required. Usually, superheater safety valves have at least 20% of total capacity required.

In your case, superheater safety valves should be set to blow at 130 lb. pressure, and the drum-valve setting changed so it will blow at 132 to 133 lb.

WHAT'S WRONG WITH THIS PICTURE?—XV

Condensate Return System—See page 288

CONDENSATE-RETURN systems of this type are used to return condensate from process to a boiler without the use of feed pumps. When correctly installed, a considerable saving in fuel may be effected. A further advantage is that the closed system usually assures a minimum of dissolved oxygen. Errors in the drawing are:

1. No Check Valve on Condensate Inlet at Trap. A check valve is necessary on the condensate-feeder line ahead of the tee. Without this, live steam would back up through the condensate line.

2. No Check Valve on Trap-Condensate Discharge. A check valve is necessary on the trap discharge to the boiler feed just after the tee. Otherwise, boiler pressure would always exist in the trap and prevent flow of low-pressure condensate.

3. The Trap Feed to the Boiler Should Not Be Controlled by One of the Main Blowdown Valves. The feed line should be tied in between the boiler and the first blowdown valve. Both main blowdown valves should be closed at all times when the boiler is not being blown down.

4. No Stop Valve between Condensate Line and Blowdown Pipe. A stop valve close to the blowdown pipe is necessary in case of failure of the condensate pipe or fittings. Otherwise, it would be impossible to shut off this line. The valve should be extra heavy if for over 100 lb. pressure.

5. No Check Valve on Condensate Feed

Line to Boiler. A check valve is required on the condensate line just before the stop valve at the blowdown-pipe connection. The check may be repaired while the boiler is in service by closing the stop valve.

6. Live Steam Connection Wrong. It is incorrect to tap the live steam supply from the safety-valve connection. Connection should be made from the main steam line.

7. Check Valve Wrong in Blowdown. No check valve should appear as shown, as it would prevent blowing down the boiler.

8. No Stop Valve in Live-Steam Line. A stop valve is required to permit repairs to the system without taking the boiler out of service. One valve should be close to the boiler and another close to the trap.

9. No Drain Connection. As shown, it is impossible to drain the condensate system. This is often necessary for repairs, and for sludge removal. A gate valve, with a diameter of at least ½ in., should be provided in the bottom of the condensate tank.

10. No Check Valves in Two Drip Lines to Condensate Tank. Check valves should be provided in all drip lines to prevent condensate from backing up in the ones not protected.

11. Insufficient Drip-Line Pressure. Five lb. pressure would raise condensate effectively slightly over 10 ft. With a 13-ft. head, it would be necessary to have at least 6½-lb. drip pressure to cause proper flow. If not practicable to increase the drip pressure, it would be necessary to instal a pumping or "intermediate" return trap.

12. Insufficient Head Between Trap and Water Line. Trap should never be less than 4 ft. above the water line of the boiler. A lower elevation than this will cause uncertain flow of condensate to the receiver.

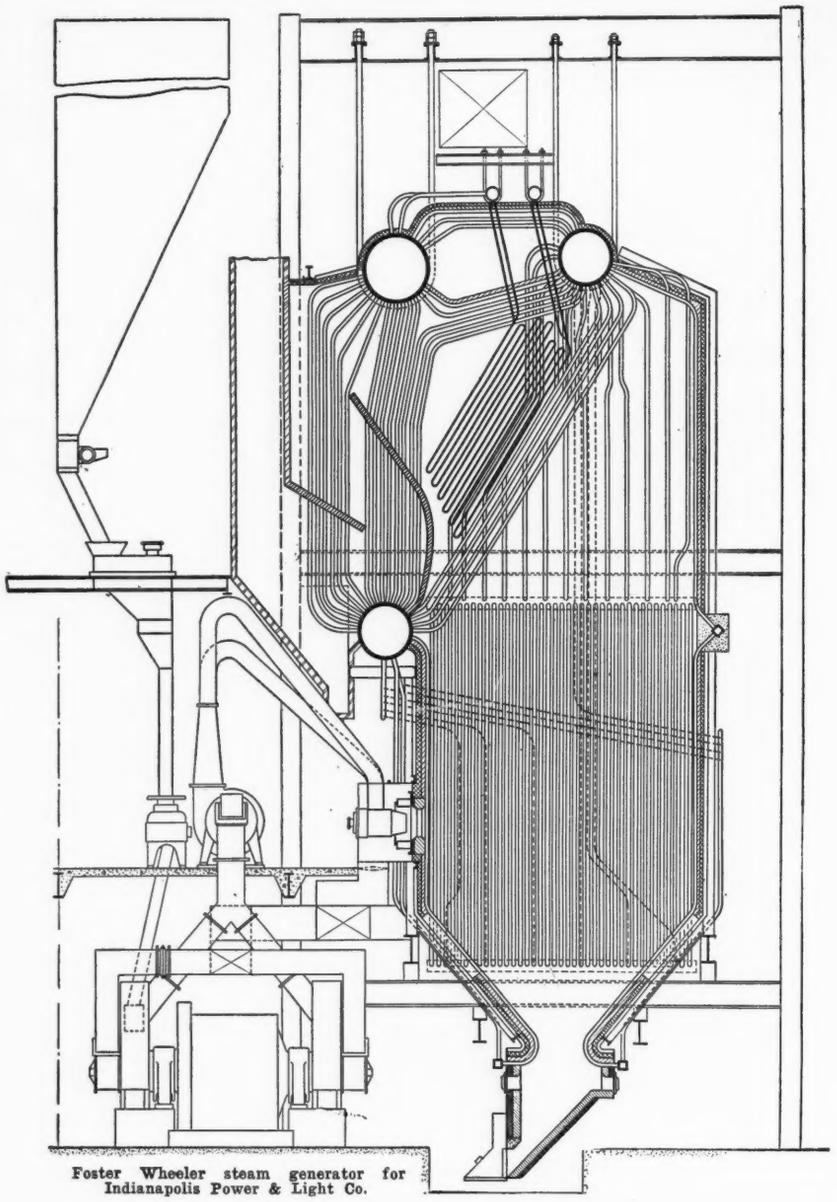
13. No Vent Should Be Used. The condensate return tank operates under pressure and no vent should be connected without a shut-off valve.

Flushing, N. Y. HARRY M. SPRING

Indianapolis Utility To Increase Capacity

Indianapolis Power & Light Co. has ordered from Foster Wheeler Corp. two steam-generating units, each to produce 300,000 lb. of steam per hr. at continuous rating, for its Kentucky Ave. station in Indianapolis. Boiler units proper will be 3-drum, vertical, bent-tube designed for a 4-hr. peak output of 350,000 lb. of steam per hr., design working pressure to be 683 lb. per sq. in., and final steam temperature, 785 deg. F.

Heating surface of each unit is 20,050 sq. ft., not including airheater. Drums are built of 70,000-lb. tensile strength steel, fusion welded with a.c. Temperature of feedwater entering boilers will be 390 deg. and stack temperature 370 deg. With 15% CO_2 leaving the boiler, overall efficiency is expected to be over 85%. Design is shown in the accompanying drawing. Boiler surmounts a large, rectangular furnace, all four walls of which are water-cooled.



Foster Wheeler steam generator for Indianapolis Power & Light Co.

Pulverizers are Foster Wheeler (Hardinge type) double-classifier, ball mills. Preheated air at temperatures up to 525 deg. will be available at the mills and burners. Burners and feeders will be located on the operating floor, with automatic feed- and level-controlled pulverizers immediately below. Each furnace will be fired by two pulverizers, each having a capacity of 21,000 lb. of coal per hr., driven by motors through gear and pinion drives.

Each end of a mill is fitted with a classifier that automatically separates out oversize particles in the fuel stream leaving the mill. These particles are returned on a spiral conveyor to the mill for further grinding. Four intervane burners 27 in. in diameter will be placed in each furnace, with capacity of 10,500 lb. of coal per hr. each.

Bare-tube, convection superheaters will be placed on each steam unit, with both headers fitted to the top of the boiler setting. Provision will be made for adding more superheater surface in the event it is desired to increase final steam temperature.

Seneca Mills Install New Steam-Generator Unit

Seneca Knitting Mills, Inc., Seneca Falls, N. Y., is installing a 2,250-sq.ft., 250-lb. Riley steam-generator fired by a Jones side-dump stoker. It is a 2-drum compact unit of new design having side waterwalls with tubes interlacing across the roof of the furnace to connect to opposite headers. A Cochrane feedwater heater, Reliance gage column, Yarway blow-off valves and closed blowdown tank (due to sewer condition), Crane valves, Bailey feedwater regulator, and Cash automatic draft, pump and stoker regulators are being fitted. This unit will replace a 1,500-sq.ft. Kewanee horizontal-tubular and a 250-sq.ft. Pacific horizontal tubular boiler in supplying process steam, principally for drying and heating. Generating equipment will later be added in the space now occupied by the old boilers. First steaming was Mar. 30, and the plant is expected to be complete about May 25. H. Sessler & Son, Waterloo, N. Y., are making the installation, and John L. Graham is consulting engineer.

THE ENGINEER'S BOOKSHELF

Steam Power

STEAM POWER STATIONS (1936)—*By Gustaf A. Gaffert, Assistant Mechanical Engineer, Sargent & Lundy, Inc., formerly Assistant Professor of Heat Power Engineering, Worcester Polytechnic Institute. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 559 pages, 6x9 in. Price $4.50.*

A first edition, such as this, has its advantages in presenting the subject in terms of today's thinking and today's most modern equipment. Proof is found in the adequate presentation of the most recent development in mercury and other binary cycles, the Velox boiler, the Port Washington Station, latest boiler designs, fans, firing equipment, condensers, turbines, etc. In addition to timeliness, this volume has the virtue of dealing with its subject in a comprehensive manner, except for the deliberate omission of the structural and electrical side.

Presentation is intensely practical, and, in this respect, is helped by the inclusion of 380 illustrations, drawings and photographs of commercial equipment. The book contains some theory, but only that helpful in a practical interpretation of power-plant problems. It begins with fundamentals and simple things and expands progressively to complete integration of all machinery.

Materials

MATERIAL HANDBOOK (3rd Edition). *By George S. Brady, Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 661 pages, 4¼x7 in. Flexible fabrikoid covers. Price $5.*

Items relating to engineering construction materials now include more comparative data on physical properties, patented and trade-named materials, have been grouped in their particular classifications to give a broader picture, and many new materials have been added. Yet no descriptions are so exhaustive that they make the volume unwieldy. It is still in every sense a handbook, with enough information for intelligent selection of a proper material for a particular job. Items are arranged alphabetically, and there is also a comprehensive index.

Air Conditioning

PRINCIPLES OF HEATING, VENTILATING AND AIR CONDITIONING (1937)—*By Arthur M. Greene, Jr., Dean of Mechanical Engineering School, Princeton University. Published by John Wiley & Sons, Inc., 440 4th Ave., New York, N. Y. 6x9 in., illustrated, 446 pages. Price $4.50.*

Although principally a college text, this book contains much material of value to consulting engineers. It deals mainly and comprehensively with the subject of heating. Ventilators are discussed in chapters on indirect-steam heating, unit heaters and warm-air furnace heating. Air conditioning is covered rather briefly in chapters on methods of application, properties and conditioning of air, and unit heaters—air-conditioning and plenum-chamber.

In a chapter on automatic controls, the author describes the use of orifices—in heating systems and one method of control. No mention is made of the system that controls by regulating vacuum in the radiators and hence radiator temperature. The importance of recent advances in heating-system control methods would seem to warrant a somewhat longer chapter on this subject.

Water Purification

WATER TREATMENT AND PURIFICATION (1937)—*By William J. Ryan. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 242 pages, 6x9 in., illustrated, tables. Price $2.50.*

This volume is notable for its practical approach and for a simplicity of presentation that will be appreciated by the average power engineer. Incidentally, the author is well known to many *Power* readers for his frequent published answers to questions submitted on water treatment and conditioning.

It should be pointed out that the book does not confine itself to water problems encountered in steam generation, but deals also with treatment of general water supply. This, however, is no disadvantage for the industrial power reader, since he is concerned with both.

Chapters deal with water impurities, sedimentation and coagulation, filtration, water analysis, lime and soda ash process, zeolite softeners, boiler feedwater treatment, general considerations, disinfection of water, tastes and odors, miscellaneous treatment, and prevention of corrosion.

Power and Engines

STEAM POWER AND INTERNAL-COMBUSTION ENGINES (2nd Edition). *By Dudley P. Craig, Head of the Mechanical Engineering Dept., Colo. State College of Agriculture and Mechanic Arts, and Herbert J. Anderson, formerly instructor of Mechanical Engineering, Purdue University. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 571 pages, 6x9 in. Price $4.50.*

This is a presentation of fundamental principles of heat-power machinery and a description of development, construction and operation of essential equipment of the modern power plant. The importance of engineering methods to determine exact results pertaining to efficiency and performance of various types of equipment have been stressed.

Development of the high-speed diesel and its application in many new fields has resulted in much change in internal-combustion practice. The use of high-pressure, high-temperature steam in both central stations and industrial plants has resulted in changes in fuel-burning, furnace and boiler design. Boiler-water analysis and treatment have assumed greater importance. All these things have been incorporated, as well as the new steam tables and Mollier diagram of Professor Keenan.

Steam Turbines

STEAM TURBINE OPERATION (2nd Edition)—*By William J. Kearton. Published by Pitman Publishing Corp., 2 West 45th St., New York, N. Y. 5½x8½ in., illustrated, 346 pages. Price $3.75.*

This book is the only text on operation of steam turbines, hence is of real value to superintendents and steam-plant operators. Two new chapters have been added in this second edition. One deals with the practice of regenerative feed-heating, and the other discusses erosion of blading in low-pressure stages of large capacity units.

For American readers it is unfortunate that the illustration material is largely of English turbines.

BRIEF REVIEWS

SYMPOSIUM ON RADIOGRAPHY AND X-RAY DIFFRACTION METHODS (1937). *Published by American Society for Testing Methods, 260 S. Broad St., Philadelphia, Pa. Price $4.00.*—A symposium of six papers on radiography, covering principles, foundry applications, radiography in the welding shop and specifications, and 6 papers on X-Ray difraction.

ELECTRICAL YEAR BOOK (1937). *Published by Emmott & Co., Ltd., 31 King St. West, Manchester 3, England. Price 1 shilling, 6 pence*—380-page, 6x4-in. handbook. General and technical information on electrical equipment and services.

BASIC INDUSTRIAL MARKETS IN THE U.S.—GAS AND ELECTRIC UTILITIES (1937). *Published by Bureau of Foreign and Domestic Commerce, Washington, D.C. Price 10 cents*—157 pages, 8x10½ in. Statistical data, on a county basis, listed for each major group in the electrical power industry, both by type of production and type of ownership. Tables show total installed electric and gas power producing capacity by state and county, and number of domestic customers by state and county for both gas and electricity. Nine maps show density, location and capacity.

CURRENT HYDRAULIC LABORATORY RESEARCH IN THE U.S. (1937). *Published by U.S. Department of Commerce, National Bureau of Standards, Washington, D.C. Price not stated*—Bulletin V-1, 118 pages, lists organizations and individuals engaged in hydraulic research work, and describes method, status, and purpose of projects.

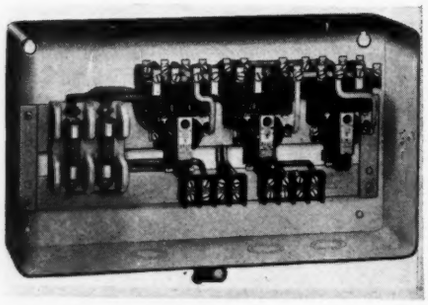
INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS (1937). *Published by A.S.T.M., 260 S. Broad St., Philadelphia, Pa. Copies free on request.*—120-page publication lists 796 standards as of Jan. 1, 1937. Of value to the engineer wishing to determine whether A.S.T.M. has issued specifications, test methods or definitions covering a material or subject.

WHAT'S NEW IN PLANT EQUIPMENT

PORTABLE BALANCING EQUIPMENT

FOR BALANCING large turbines, auxiliaries such as fans, exhausters, pumps, and motors, this unit has two devices for measuring vibration. "Two-direction" vibrometer, at right in illustration, measures in two directions simultaneously and also indicates wave form. Single-direction meter is shown at center. Stroboscopic lamp with three neon tubes at left. In left foreground, breaker head and phase adjuster is shown coupled to synchronous motor, used for balancing 60-cycle machines running at 3,600, 1,800 or 1,200 r.p.m. by placing motor and breaker head at any point convenient to operator. For other speeds, breaker head is driven from shaft end by tachometer point.

Electrocon Corp., 6 Varick St., New York, N. Y.



AUTOMATIC ALTERNATOR FOR DUPLEX PUMPS

THREE "Bulletin 700" relays automatically switch float-switch control circuit from one pump starter to the other each time unit operates. Panel may be used also with two float switches so that idle pump can be used as automatic booster. Also applicable to duplex-motors in refrigerating units, fans, compressors, etc. Pilot control may be pressure switch, vacuum switch, thermostat, or 2-wire push button instead of usual float switch.

Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.

OVERLOAD PROTECTION FOR A.C. MOTORS

"THERMO-MAGNETIC OVERLOAD FEATURE" applicable to all a.c. I-T-E motor-protecting circuit breaker. Standard devices available for any a.c. motor up to 1,000 hp., 550 volts. Overload protector has electro magnet excited by current flowing in series overload coil, bi-metal thermal element mounted at back of magnet and heated by current induced in a short-circuited turn of copper adjacent to it, and hinged laminated iron armature which works in conjunction with magnet and is tripped during overload conditions. Bulletin 237.

I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia, Pa.

ZEOLITE WATER SOFTENER

TWO-FLOW softener has two tanks. Hard water enters at bottom of one, flows up through zeolite and over through a pipe into second tank, through a second zeolite bed, and emerges as soft water. Two-flow unit said to provide faster flow rate, lessen amount of water required for backwashing and to have a higher salt efficiency which effects saving in zeolite. Single solo valve simplifies backwashing and regeneration.

Elgin Softener Corp., Elgin, Ill.

INDICATING FUSES

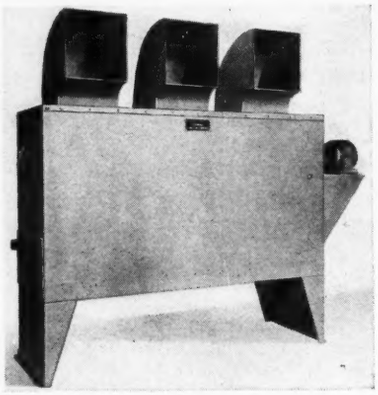
RENEWABLE fuses have neon light permanently attached which glows when fuse blows out. Neon light is encased within handle secured to the fuse, and also serves as a handle in extracting fuse. Either knife-blade or ferrule type, 250 to 600 volts, 3 to 600 amp.

Indicator Corp., 32-36 Green St., Newark, N. J.

SMALL-BORE TUBE CLEANERS

"600 SERIES" cleaners for small tubes, as in condensers, heaters, heat exchangers, and marine boilers. Made in a range of motor diameters from $\frac{15}{32}$ to $1\frac{7}{16}$ in. Air-driven motor, using rotor with four paddles, operates on pressure up to 100 lb. and consumes from 10 to 30 cu.ft. of air per min., depending on size. Will also operate on steam. Not claimed to remove heavy hard accumulation of scale, but will remove soft accumulation or a thin hard one.

Elliott Co., Jeannette, Pa.



AIR HEATER

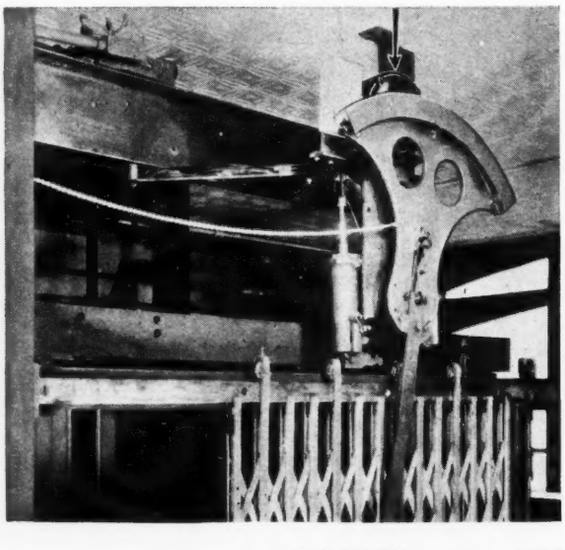
"AIRHEATER" has bank of extended fin U-bend coils through which air is drawn by multi-blade fans. Externally-mounted motor direct-connected to fan shaft through flexible coupling. Made in seven standard sizes, each made in three different assemblies: upright for floor mounting, horizontal for overhead suspension, and inverted for overhead or side-wall suspension. Coil rack is built into casing so that, by unbolting coil cover plate, coil may be drawn out for inspection and cleaning.

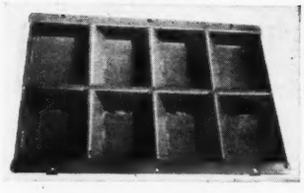
Airtherm Mfg. Co., 1474 South Vandeventer Ave., St. Louis, Mo.

ELEVATOR GATE-CLOSING MECHANISM

SO-CALLED "torque" motor important part of this mechanism. Opening and closing lever attached to quadrant driven by motor which can be stalled on circuit at end of travel without taking more than approximately full-load current, and without overheating. Motor is switched on by gate-control mechanism until gate reaches end of travel, then is stalled at full torque until next movement of car, which reverses motor to close gate. Motor said to be adaptable to other uses requiring on-and-off cycle.

Ohio Electric & Mfg. Co., Cleveland, Ohio.





WELDED MOTOR-GENERATOR BASE

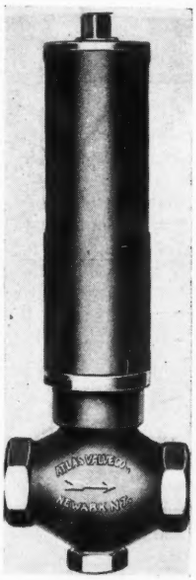
TOP, SIDES and base flange pressed from a single sheet, reinforced with V-shaped ribs welded by electric-arc process. Ribs said to provide unusual strength and freedom from distortion, and all welds are "stress-relieved" after completion.

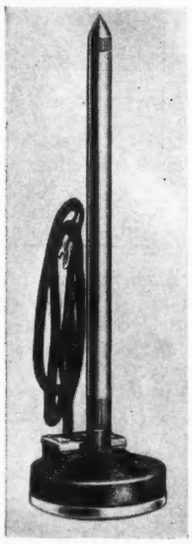
Reliance Electric & Engineering Co., Cleveland, Ohio.

HIGH-PRESSURE REDUCING VALVE

FORGED-STEEL body, high-pressure reducing valve has formed packing of special material said to be immune to water, oil and other fluids. Pressure on seat is balanced by piston so that variations in high initial pressure have little effect on reduced pressure. Internal parts of stainless steel.

Atlas Valve Co., 282 South St., Newark.





VIBRATION PICK-UP

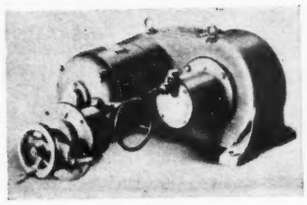
BIMORPH crystal, mounted inside of aluminum case, flexes of its own inertia and sets up voltage impulses of exactly same wave form as that of mechanical motion. Response is practically linear up to resonant frequency of 2,500 cycles. Pick-up used with oscilloscope having built-in amplifier and voltmeter on output to determine frequency, amplitude, and velocity of vibration.

Sundt Engineering Co., 4238 Lincoln Ave., Chicago, Ill.

SPEED REDUCER *(Photo right)*

ADDITION to line of worm-gear speed reducers has center distance of 7¾ in. with ratios of 3⅞ to 1 up to 2,450 to 1. Ratings range from ½ to 27½ hp. in single-reduction output-torque ratings of 12,600 to 21,000 in. lb. in double-reduction types.

Foote Bros. Gear & Machine Corp., 5301 S. Western Blvd., Chicago, Ill.



VARIABLE-SPEED MOTOR

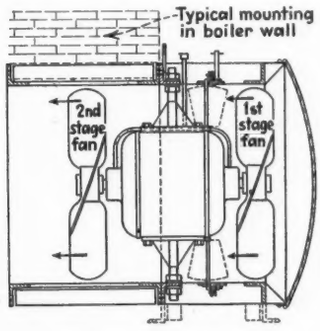
HYDRAULIC remote control said to provide smooth regulation and an infinite number of speeds within range specified. Liquid at remote-control cylinder is forced through copper tubing to cylinder at variable-speed unit; movement of this cylinder changes speed. Controlled through handwheel shown.

U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles, Calif.

ELECTRIC PLIERS *(Photo above)*

FOR SOLDERING lugs up to 1,050 amp., or sweating pipe fittings up to 2½ in. diameter under continuous operation (pipe fittings up to 4 in. diameter in intermittent operation), large size pliers said to heat work evenly from both sides, eliminate fire hazard, sweat joint without unsweating adjacent connections, and to hold work firmly while soldering. Line current is reduced to low voltage to avoid possibility of shock.

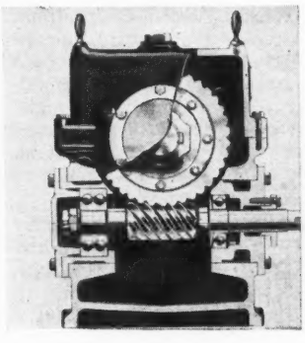
Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.

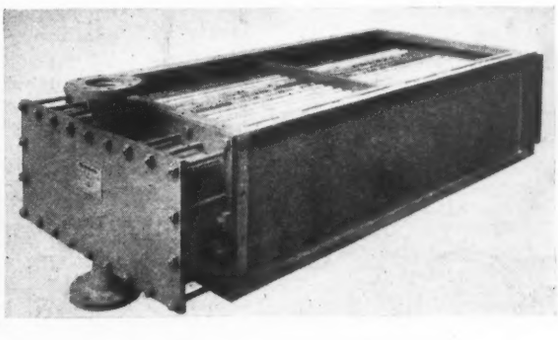


BLOWER UNIT

FOR FORCED-DRAFT of either hand-fired, stoker-fired, oil- or gas-fired boilers, or for secondary air supply to pulverized-fuel burning boilers, this blower obtains pressures of 6 or 7 in. w.g. by a 2-stage combination. Self-contained unit consists of constant-speed electric motor, with double-extended shaft; two propeller fan wheels, one mounted on each shaft; integral damper control and air redirecting mechanism built in between fan wheels.

L. J. Wing Mfg. Co., 154 W. 14 St., New York, N. Y.





DIESEL ENGINE EXHAUST PYROMETER

"ALNOR" Type 3023 pyrometer has self-contained selector switch for measuring exhaust temperatures of small diesels. Selector switch in either 2, 4, 6, 8, 10, or 12 points. Scale range of either 600, 800, 1,000, 1,200, or 1,600 deg. F.

Illinois Testing Labs., Inc., 420 N. La Salle St., Chicago, Ill.

MINIATURE PANEL INSTRUMENTS

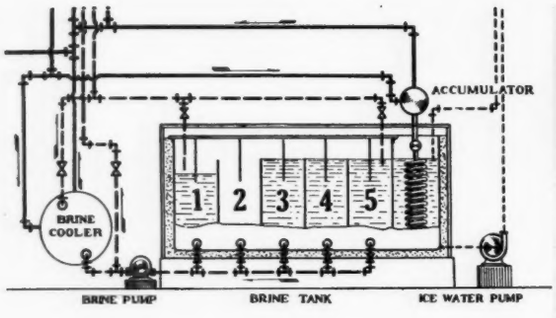
FOR USE as ammeters, voltmeters, power-level meters and volt ohmmeters, either a.c. or d.c., entire line employs only two types of mechanism, providing easy interchangeability of parts. Capacities as low as 20 microamperes in moving-coil types. Rated 750 volts.

Westinghouse Electric & Mfg. Co.. East Pittsburgh, Pa.

AIR COOLERS

FOR COOLING air or other gas for turbo generators, synchronous condensers, water-wheel generators, etc. Shell consists of two steel plates, edges of which are bent to form a rigid channel, and which are fastened by cross members welded to sides of cooler. Water boxes made from copper-bearing steel. Cooling surface of Admiralty metal tubes, upon which spirally-wound copper fins are mounted. Tubes are rolled solidly into Muntz metal plates. Any single tube may be removed from tube bundle without disturbing adjacent tubes.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



BRINE TANK

MULTI-COMPARTMENT tank prevents cold brine from being affected by warmer return brine. With compartments Nos. 1, 2, 3 and 4 full, consumption begins at No. 4, No. 5 being empty. Brine pumped from No. 4 returns to No. 5, and as No. 4 is empty, brine is taken from No. 3, warm brine still returning to No. 5, which fills up and overflows into No. 4, etc. This is said to use only lowest temperature brine for cooling, and without increase in initial temperature at any time. When process is ended, and consumption of cold brine ceases, compartment No. 1 is empty, and Nos. 2, 3, 4 and 5 are full of warm brine, to be cooled over a relatively long period by refrigerating machine.

Carbondale Div., Worthington Pump & Machinery Corp., Harrison, N. J.

VALVE RESEATER

ILLUSTRATION shows reseating tool in use on a steam valve. Cutting tool removes old seat, and at the same time threads a hole for inserting new seat made with an interlocking ground-joint to provide leak-proof connection with base of valve. 15-part kit contains all reseating tools. Seats in sizes up to 5-in. diameter.

Standard Reseater Corp., 423 West 126th St., New York, N. Y.

WET-SURFACE PAINT

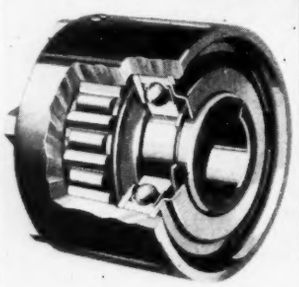
"WET-X-HALE," when mixed with paint, lacquers and varnishes, can be applied directly on to damp, moist and wet-from-rain surfaces. In spite of moisture deposit on surfaces and more moisture in air, reaction of this compound said to deposit paint film firmly on surface because it absorbs water, then separates from paint and forces itself with absorbed water through paint to top of film, where it decomposes and evaporates.

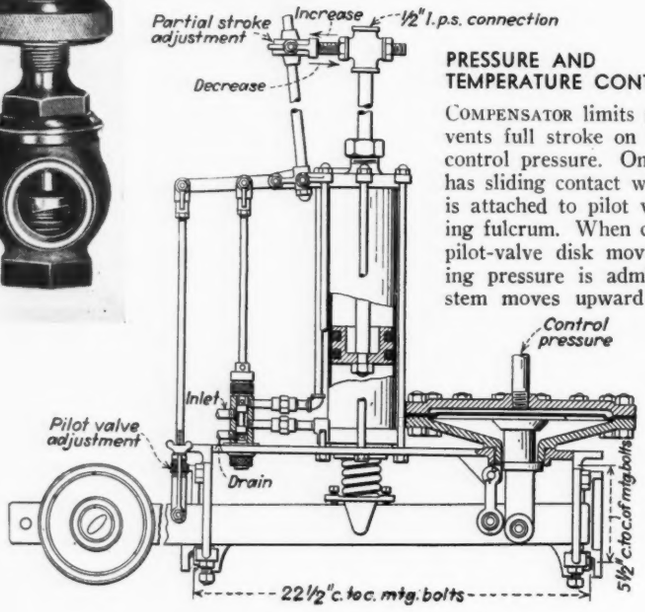
Wet-X-Hale Paint-Compound Co., 572 Greenwich St., New York, N. Y.

FREE-WHEELING CLUTCH *(Left)*

MULTIPLE CAMS, spaced alternately with hardened-ground steel rollers, distributes load evenly on each cam, which is said to permit high-torque loads without danger to cam surfaces and allows greater cam-contact surface for given clutch diameter. Cam action governed by two leaf springs that contact shouldered surfaces milled at each end of cams. Point of spring contact at center creates rocking action so that when speed of inner and outer races synchronize, cams immediately lock. A ball bearing at one end separates members and stabilizes load. Opposite end of unit is prepared for attachment of sprocket wheel, ratchet arm, or belt pulley.

Morse Chain Co., 7601 Central Ave., Detroit, Mich.





PRESSURE AND TEMPERATURE CONTROLLER

COMPENSATOR limits piston travel and prevents full stroke on each slight change of control pressure. One end of compensator has sliding contact with piston stem; other is attached to pilot valve and forms floating fulcrum. When control pressure drops, pilot-valve disk moves downward, operating pressure is admitted to cylinder, and stem moves upward causing floating fulcrum to move pilot-valve disk upward to neutral position. May be adapted to temp. control.

Davis Regulator Co., 2541 Washtenaw Ave., Chicago, Ill.

VIBRATING SCREEN *(Photo left)*

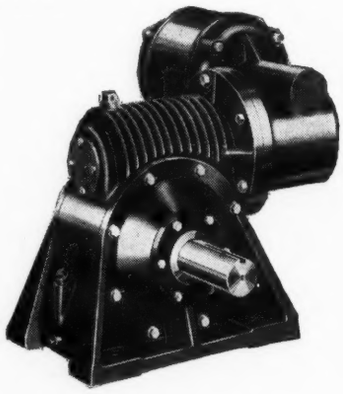
ELECTRO-MAGNETIC motor, attached mechanically to screen, is powered through a rectifier and small auto transformer, permitting use of standard a.c. Dual magnets apply force equally in both directions, eliminating springs. Rectifier splits a.c. cycle into halves and delivers each successive half wave in turn to upper and lower magnets. Reciprocating motion is transmitted to screen without any revolving parts. 25, 50 or 60 cycles, and 440 volts, high frequencies being best for fine screening.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

FLUE-GAS METER

"FUEL-RATIOMETER," for measuring CO_2 and stack temperatures, has 4 high-resistant wires in a Wheatstone-Bridge circuit—two in an air-surrounded cell, two in analyzing cell open to gas flow. If CO_2 envelops 2 filaments in analyzing cell, rate of heat travelling from filaments is slower through CO_2 than air, existence increases because filaments become hotter, and current starts to flow in bridge circuit in one direction. Resistance change is calibrated by meter to read in direct percentage CO_2.

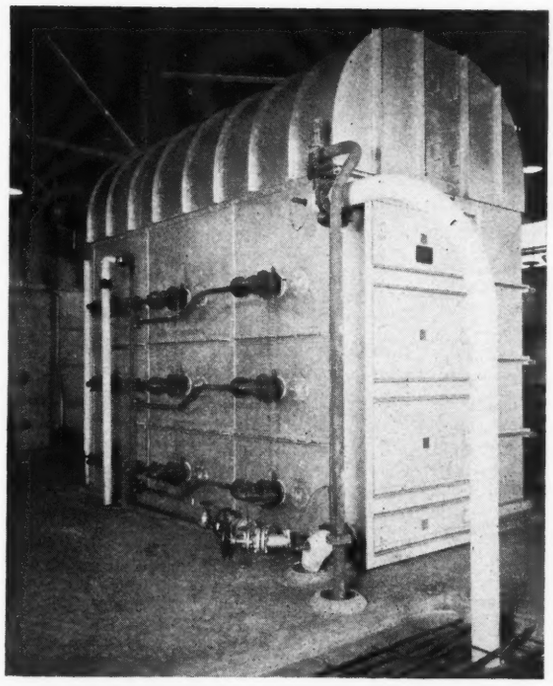
Wm. O. Hebler Co., 830 Broad St., Newark, N. J.



FRACTIONAL-HORSEPOWER GEAR MOTORS

"IXL" motorized speed reducers range from 1/50 to ¾ hp. in ratios from 2 to 1 up to 8,000 to 1. High-carbon, alloy-steel shafts, anti-friction bearings, and automatic lubrication. Bulletin 750.

Foote Bros. Gear & Machine Corp., 5301 So. Western Blvd., Chicago, Ill.



MODERN ECONOMIZER

8,640-sq.-ft. Foster Wheeler economizer at a Midwest public utility. 140,000 lb. of water per hr. is heated to 360 deg. F. for a 11,500-sq.ft. boiler operating at 731 lb. pressure and 700 deg. final temperature. Economizer elements are of composite extended-surface type, each individually removable, and sheet-steel doors are provided for access to tube joints

POWER LINES

A.S.M.E. Announces Program For Detroit Meeting, May 17-21

A tentative program for the 1937 semi-annual meeting of the A.S.M.E., to be held in Detroit, Mich., May 17-21, with headquarters at the Statler Hotel, has been announced. Three power and two fuel sessions are planned for the 5-day program.

Papers in these two sessions include: "Design, Construction and Operation of Springwells Station of the Detroit Department of Water Supply," by W. C. Rudd, asst. engr. of power, Dept. of Water Supply, Detroit, and B. J. Mullen, chief plant engr., Springwells Station; "Separation and Removal of Cinder and Fly Ash," by A. C. Stern, supt. WPA Project 6010, New York; "Incinerators—Municipal, Industrial, and Domestic," by H. F. Hersey, vice-president and general manager, C. O. Bartlett & Snow Co., Cleveland; "Industrial Power Plants," by E. Boomhaur, plant engr., Dodge Motor Corp.; "The Pooling of Power Sources in a Large Industrial Center," by J. W. Parker, vice-president and chief engr., Detroit Edison Co., and R. E. Greene, Engrg. Division, Detroit Edison Co.

"The Hydraulic Circuit of Condensers," by G. H. Van Hengel, consultant, Detroit Edison Co.; "Operating Experiences in the Steam and Power Dept. of the South's First Alkali Plant," by G. P. Avery, supt., Power and Steam Dept., Southern Alkali Corp.; "Formulas for Stresses in Bolted Flanged Connections," by E. O. Waters, assoc. prof. M.E., Yale University, D. B. Rossheim, M.E. in Charge Mech. Design and Metal, M. W. Kellog Co., New York, D. B. Wesstrom, engr., Travelers Indemnity Co., and F. S. G. Williams, dist. mgr., Taylor Forge and Pipe Works, New York.

On May 19, a panel discussion on spreader-type stokers will be led by J. F. Barkley, supervising engr., Fuel Economy Service, U. S. Bureau of Mines. Also included in the meeting is a session on condensers, in which two papers will be presented: "Prevention of Surface Condenser-Tube Failures," by R. E. Dillon and G. C. Eaton of Edison Elec. Illum. Co. of Boston, and H. Peters, asst. prof. of Aeronautical Engrg., M.I.T.; and "Condensation of Flowing Steam," by J. I. Yellott, asst. prof. M.E., Stevens Institute of Technology, and C. K. Holland, Mech. Engrg. Div., Phoenix Engrg. Corp., New York.

N. J. Smoke Abatement Assoc.

Industrial Smoke Abatement Association of Hudson County, N. J., re-elected as president, A. W. Akins, supt. of Power and Mechanical Depts., Standard Oil Co. of N. J., Bayonne, N. J., and named as first vice-president G. H. Binder, assistant to president, Callite Products Co., Union City, N. J. The association was organized last year to cooperate with William G. Christy, smoke abatement engineer of Hudson County, and is an outgrowth of the Industrial Fuels Conference in Jersey City in March, 1936.

Coal Conference in Cincinnati

A conference on "Marketing Steam Coals" was held in Cincinnati, March 22, by the Fuel-engineering Division of Appalachian Coals, Inc. Discussion at the conference was concentrated on the engineering phases of the use of coal for steam generation. H. A. Glover, assistant to president, Island Creek Coal Sales Co., Cincinnati, spoke on "Purchase and Sale of Coal by Steam Cost Evaluation."

B. E. Tate, chief engineer, National Cash Register Co., Dayton, Ohio, presented a talk on "The Use versus the Scientific Value of Coals for Steam Generation," and C. E. Payne, manager of the Fuel Consultation Service Department, Consolidation Coal Co., New York, described "The Relation of Burning Equipment to Coal Selection."

B.C. Electric Railway Co. Enlarges Ruskin Power Plant

A second 63,000-kw. turbo-generator is to be installed by the British Columbia Electric Railway Co. at its Ruskin power plant on the Stave River, 40 miles east of Vancouver. Completion of the work is scheduled for Oct. 1, 1938. A. Vilsstrup, chief electrical engineer for the company, and E. E. Carpenter, consulting engineer in charge of construction, will supervise the work, which will involve an estimated expenditure of $1,500,000. The new development will bring capacity in the company's hydro-electric plants on the lower mainland to approximately 335,000 kw., not counting its Vancouver steam standby plant.

The present Ruskin power plant was built in 1929 and 1930, with the installation of one 63,000-kw. generator, but with sufficient space for the one that is now being installed. The power house can be extended to include two more generators, if need be. Contracts have already been let for approximately $700,000, and the Dominion Engineering Works, which built and installed the first turbine, will put in the present one and a 19-ft. butterfly valve. The generator will be made by Canadian Westinghouse Co.

New York University Dedicates Engineering Bldg.

New York University College of Engineering dedicated its new engineering building and power plant April 3, in honor of Dean Emeritus Collins P. Bliss, who retired as administrative head of the College of Engineering last July after 40 years as a member of the faculty.

The new building contains classrooms, laboratories, a library, and a plant for furnishing light, heat and power to buildings on the 50-acre campus. Designed by Prof. Andrew I. Peterson of the College of Engineering faculty, it has three 4,000-sq.ft. boilers, a 150-kw. steam turbo-generator, two 150-kw. and one 250-kw. diesel generator sets. In winter months, the turbo-generator will carry most of the load and exhaust steam will be used to operate the central campus heating system. During the summer, when no heat and very little electricity is used on the campus, current will be generated by the diesel sets, which will also act as auxiliary units for winter peak loads and will supply additional power necessary to produce 100 mile-an-hour air speeds for the wind tunnel in Guggenheim Aeronautics Laboratory.

John Scott Awards Announced for 1937

Dr. W. D. Coolidge and Dr. Irving Langmuir, director and associate director respectively of General Electric's Research Laboratory in Schenectady, N. Y., and Dr. Evarts A. Graham of the School of Medicine of Washington University in St. Louis, Mo., were recipients of the John Scott 1937 awards granted by the City of Philadelphia at a dinner in March by the Amer-

ican Philosophical Society. With each award went a certificate, a copper medal, and $1,000 in cash.

The award to Dr. Coolidge was based on his application of a new principle in X-ray tubes; to Dr. Langmuir for his chemical and physical discoveries resulting in improved gas-filled incandescent lamps; and to Dr. Graham for his application of the X-ray to the study and diagnosis of gall bladder conditions.

Of considerable interest is the award itself, founded by John Scott, who in 1816 left $4,000 to the City of Philadelphia, the income from which was to be "laid out in premiums to be distributed among ingenious men and women who make useful inventions." It was originally stipulated that no award was to carry a cash premium of more than $20. History reveals that John Scott was a chemist in Edinburgh, Scotland, but just why he chose Philadelphia for his grant is a mystery. It is thought that his attention may have been drawn to the city either through the American Philosophical Society or his admiration of Benjamin Franklin, whom he may have met when Franklin visited Scotland in 1769.

When the Fund was taken over by the Board of City Trusts, the principal had grown to $21,000, and in 1917, 100 years after the original grant, it amounted to $100,000. So the Board appealed to the courts and got permission to increase awards to a maximum value of $2,000, but so far it has not been necessary to go over $1,000.

High-Pressure Steam Record

A new high in industrial power production was achieved recently at the Ford Motor Co.'s River Rouge plant power house when a high-pressure boiler produced 1,040,000 lb. of steam per hr. The 5-drum, water-tube boiler, placed in service last July, generates steam for a 110,000-kw. turbo-generator and several smaller units.

While engineers said that the steam output record of 1,040,000 lb. per hr. may have been equalled or surpassed by boilers of lower pressure, it is the first time such a poundage has been produced at the temperature and pressure at which the Ford boiler operates—900 deg. F. and 1,250 lb. pressure.

OBITUARIES

ALONZO K. PAUL, 68, foundry superintendent and engineer of Lumsden & Van Stone Engineering Co., Boston, Mass., died at his home in Dorchester, Mass., March 28.

RAYMOND H. CHERRY, 44, sales manager of Wire Rope Div., Wickwire Spencer Steel Co., New York, N. Y., died at his home in Westfield, N. J., on March 20, after a protracted illness of several weeks.

JAMES D. ANDREW, 62, well-known engineer and executive, died March 23 of pneumonia at his home in Englewood, N. J. Mr. Andrew was connected with Metropolitan Street Railway Co. of New York as mechanical engineer during the period of its electrification. He was for four years chief engineer of New York Edison Co., for six years superintendent of power with Boston Elevated Railway system, and for a number of years superintendent of engineering with Edison Illuminating Co. of Boston. Since 1933, Mr. Andrew was manager of American Boiler Manufacturers Association and Affiliated Industries.

HERBERT L. BATCHELDER, 72, master mechanic at Stark Mills, Manchester, N. H., for 40 years, died recently at Daytona Beach, Fla.

ALVIN O. LOMBARD, 80, inventor, whose first achievement was a water-wheel regulator, died recently at his home in Waterville, Me.

CHARLES W. FORBES, 72, for 40 years a a steam engineer and hydro-station operator at Jackson Mills in Nashua, N. H., died at his home in Nashua, Feb. 27.

PROF. ELIHU THOMSON, 83, one of America's best-known scientists of modern times, and a founder of General Electric Co., died at his home in Swampscott, Mass., March 13. Professor Thomson, with Thomas A. Edison, James J. Wood, and Charles F. Brush, were pioneers in modern electrical industry. He was one of the early arc-light inventors, experimented with the principle of a.c. transmission far in advance of commercial demands, and held over 700 patents in the United States

alone. He originated the resistance method of electric welding, which has been in continuous use from 1887 to the present time; developed the repulsion type of induction electric motor; invented the magnetic blow-out principle in lightning arresters and electric switches, the oil-cooled transformer, the constant-current transformer, and the modern process of commercially treating fused quartz.

FREDERICK R. GLOVER, 77, general executive assistant with British Columbia Electric Railway Co., died in Vancouver recently. He had been with the railway company since 1902.

DR. ALFRED DOUGLAS FLINN, 67, director of the Engineering Foundation and long a leader in organized engineering, died March 14 in Scarsdale, N. Y. Dr. Flinn's varied career saw him first as a civil engineer for Providence, R. I., then as an engineer for the Massachusetts Metropolitan Water Board, two years as managing editor of *The Engineering Record*, later combined with *The Engineering News*, general inspector for Croton Aqueduct Commissioners in New York, for many years on the Board of Water Supply of New York City, and since 1918 with many engineering societies.

PERSONALS

ALLEN VAN WYCK, Chicago, was recently elected a director of Potomac Electric Power Co., Richmond, Va.

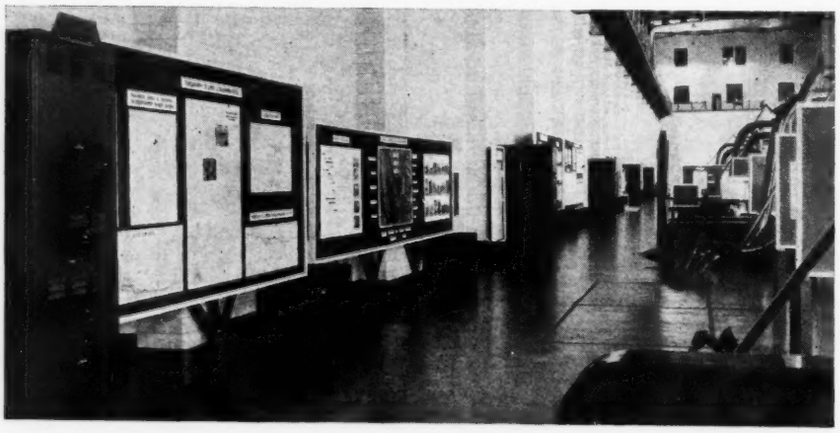
DR. ING. PAUL SCHWARZKOPF, well known Austrian metallurgist, has accepted presidency of American Cutting Alloys, Inc., New York, N. Y. Dr. Schwarzkopf developed the titanium-cemented alloys for cutting steel at high speeds that have been used in Europe during the past two years, and will spend at least six months of the year at Lewiston, Me., where the company has its manufacturing facilities and laboratory.

OSCAR H. FOGG, formerly executive vice-president of Consolidated Edison Co. of New York, has been made vice-chairman of the board, and Ralph H. Tapscott, formerly Consolidated Edison vice-president in charge of electrical operations within New York City, has been elected president and a trustee.

MERRILL BERNARD, hydraulic engineer, has been appointed chief of the River and Flood Division of the Weather Bureau, to fill the vacancy caused by the death of M. W. Haynes last November. The appointment of a hydrologist, an authority on waters, rather than a meteorologist, an authority on atmosphere and its variations,

WORLD POWER EXHIBIT MADE PERMANENT

Safe Harbor Water Power Corp., for visitors during the World Power Conference, arranged this exhibit of photographs, drawings and other material to give a comprehensive picture of technical and engineering work involved from inception of the project until its completion. Sightseers liked it so well that the company has decided to make it permanent



to head an important division is a new policy in the Weather Bureau, according to W. R. Gregg, Bureau head, and has been done to develop new flood-forecasting methods.

R. H. KIPPING, former chief engineer of Austin, Tex., municipal power plant, has been appointed assistant chief engineer of A. M. Lockett Co., mechanical engineering firm of New Orleans, La.

J. B. TROTMAN, for many years associated with Goulds Pumps, Inc., is now in Connersville, Ind., as manager of a Roots-Connersville Blower Corp. pump division.

HENRY P. HAHN, for the past five years chief engineer of the oil and refining department of the Societe Anonyme des Etablissements Jules Cocard, Paris, France, and before that a member of Crane Co.'s engineering staff, has become a member of the engineering staff of Crosby Steam Gage and Valve Co., New York, N. Y.

EDMOND C. POWERS, who has been engaged for three years in technical writing for the Lincoln Electric Co., Cleveland, Ohio, has been appointed assistant secretary of the James F. Lincoln Arc Welding Foundation, sponsor of the $200,000 arc-welding prize contest.

BUSINESS ITEMS

IRON & STEEL PRODUCTS, INC., Railway Exchange, Chicago, Ill., announces that Ed Provost, power-plant and equipment engineer, has joined the organization.

WHEELCO INSTRUMENTS CO., Chicago, Ill., recently moved their offices and manufacturing facilities to 1929 S. Halstead St., in order to provide more room for manufacturing operations.

RELIANCE ELECTRIC & ENGINEERING CO., Cleveland, Ohio, has added Elwood H. Koontz to their Philadelphia sales staff; also has announced that J. L. Buell, Jr., now heads their Detroit office, assisted by Z. A. Reader and F. J. Denison.

FOSTER WHEELER CORP., New York, N. Y., has appointed Howard B. Hall as regional director in charge of its Cleveland, Cincinnati and Pittsburgh territories with offices at 526 Superior Ave., Cleveland, Ohio.

GENERAL REFRACTORIES CO., Philadelphia, Pa., announces appointment of H. W. Porter & Co., Inc., Newark, N. J., as distributors for Newark and vicinity.

JAS. P. MARSH CORP., Chicago, Ill., has appointed Bymor Sales Corp., 322 New St., as representative in Philadelphia.

LINCOLN ELECTRIC CO., Cleveland, Ohio, has appointed W. H. Borst, graduate in mechanical engineering from the University of Illinois, and E. A. Webber, formerly with its Chicago office, as members of New York sales staff; John S. Humble as welding consultant for its Boston office.

LINK-BELT CO., Chicago, Ill., recently elected four directors to serve until 1941. Newly elected directors, Bernard E. Sunny, Chicago, and James S. Watson, Indianapolis, succeed Austin L. Adams, resigned, and Arthur L. Livermore, deceased. Re-elected directors are Staunton B. Peck, Chestnut Hill, Pa., and Harris Whittemore, Jr., Nagautuck, Conn.

CRANE CO., Chicago, Ill., has promoted J. A. Dwyer, former Philadelphia branch manager, to district manager of all Crane branches in its Eastern territory. H. S. Officer, Newark branch manager, succeeds Mr. Dwyer at Philadelphia, and J. H. Geiss moves from Hempstead, L. I., to succeed Mr. Officer at Newark.

FOOTE BROS. GEAR & MACHINE CORP., Chicago, Ill., announces following changes in territorial sales personnel: E. G. Akridge, former Chicago North Side representative, has been appointed direct factory agent in Detroit succeeding Thomas Lord, resigned; F. A. Emmons, Jr., has taken over territory vacated by Mr. Akridge; and Harry Harrison has been appointed sales engineer in Chicago Central territory.

STRAWS

Pointing the way business winds blow

ALABAMA——Magic City Brewing Co., Comer Bldg., Birmingham, J. A. Jones, sec.-treas., plans power house at new brewing plant. Cost over $125,000.

ARIZONA——Tucson has authorized two gasoline engine-driven pumps for standby at Southside waterworks. P. J. Martin, city water superintendent, in charge.

ARKANSAS——Lion Oil Refining Co., Eldorado, has approved construction of 4-in. welded-steel pipeline with booster stations from oil-refining plant at Eldorado to Ouachita River, about 12 miles, for oil transmission to terminal plant to be constructed at last noted place. Project will cost close to $85,000.

CALIFORNIA——Fallbrook Irrigation District, Fallbrook, (San Diego Co.), plans series of electric-operated pumping plants in connection with extensions in irrigation system. Bond issue of $500,000 being arranged through Federal aid.

Sears, Roebuck & Co., 2650 East Olympic Blvd., Los Angeles, plans central steam-heating plant in new 3-story department store at Central Ave. and California St., Glendale. Cost over $250,000.

Newark Chemical Co., Newark, plans welded steel pipe line in connection with new additions to plant. Entire project will cost close to $1,000,000.

COLORADO——Pueblo plans gas-generating station and pumping plant in connection with new sewage-disposal works. Project will cost about $500,000. Bond issue for $280,000, with remainder, $220,000, through Federal grant. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

CONNECTICUT——Hartford Special Machine Co., 287 Homestead Ave., Hartford, plans new boiler plant at local

MEETINGS

A.I.E.E.—*Annual Summer Convention, June 21-25, Milwaukee, Wis. H. H. Henline, national secretary.*

A.S.M.E.—*Semi-Annual Meeting, May 17-21, Hotel Statler, Detroit, Mich. Sabin Crocker, Secretary Detroit Committee, in charge.*

Canadian Electrical Association—*47th Annual Convention, June 21-24, Banff Springs Hotel, Banff, Alberta. Address Secretary, C.E.A., 804 Tramways Bldg., Montreal.*

N.A.P.E.—*Mississippi Valley Mechanical and Electrical Show, Aug. 30 to Sept. 3, Jefferson Hotel, St. Louis, Mo. Fred C. Laufketter, chairman of N.A.P.E. Convention Committee.*

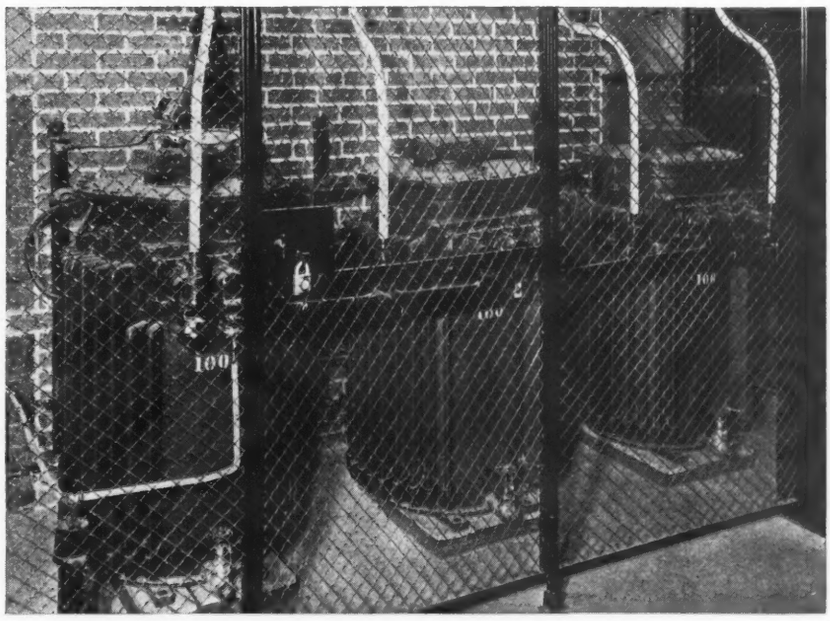
National Board of Boiler & Pressure Vessel Inspectors—*11th general meeting, Hotel McAlpin, New York, N. Y., May 24-26. C. O. Myers, sec.-treas., Brunson Hotel, Columbus, Ohio.*

Smoke Prevention Assn. and Fuel Burning & Air Pollution Exhibition—*31st Annual Convention, May 31-June 5, Hotel Pennsylvania, New York, N. Y. Frank A. Chambers, secretary-treasurer of S.P.A. and smoke inspector of Chicago, in charge.*

Universal Craftsmen Council of Engineers—*35th Annual Convention, Aug. 3-7, Stevens Hotel, Chicago, Ill. Exhibition of power equipment by 150 manufacturers in conjunction with convention. D. W. Haering, 3408 W. Monroe St., Chicago, Ill.*

FIREPROOF TRANSFORMERS

Three 100-kva. G.E. Pyranol transformers, installed in the plant of Eli Lilly Co., Indianapolis, Ind. Unusual in this installation is the absence of a fireproof vault, made possible by noninflammable Pyranol. This permitted short secondary leads to load centers, and an economical installation



works. Greenwood & Noerr, 525 Main St., consulting engineers.

IDAHO——Coeur d'Alene has asked bids for new steam-electric municipal plant. Cost about $300,000, with equipment. Rocky Mountain Engrg. Co., Denver, consulting engineer.

Clearwater Valley Light & Power Association, Lewiston, plans steam-electric generating plant. Fund of $325,000 through Federal aid.

ILLINOIS——Maywood contracted Allied Bridge & Construction Co., 201 North Wells St., Chicago, for two water-softening plants. Cost about $295,000. Consoer, Townsend & Quinlan, 205 West Wacker Drive, Chicago, consulting engineers.

Kraft-Phenix Cheese Corp., 400 North Rush St., Chicago, plans power plant for central heating service in new 9-story plant on Peshtigo Court, near Grand Ave., 218x408 ft. An air-conditioning system will be installed. Cost about $2,000,000. Mundie, Jensen, Burke & Havens, 39 South LaSalle St., architects.

Woodstock contracted Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for turbo-generator and auxiliary equipment, and for condenser with auxiliary equipment, at $109,653.

INDIANA——Public Service Co. of Indiana, Indianapolis, plans welded-steel pipeline for natural-gas transmission to Lafayette, Ind. A control and distributing station for natural-gas service will be built.

State Hospital Board, Indianapolis, plans coal-handling system and other equipment at state hospital, Evansville. Bevington-Williams, Inc., Indiana Pythian Bldg., Indianapolis, consulting engineer.

IOWA——Veterans' Administration, Washington, D. C., contracted James I. Barnes, Wilhoit Bldg., Springfield, Mo., for boiler plant at institution at Knoxville. Cost about $175,000.

KANSAS——Canton plans municipal gas plant. Cost about $50,000. Bond issue of $30,000 authorized; remainder through Federal aid. Hefling & Hughes, West Second St., Hutchinson, consulting engineers.

Clay Center is considering improving municipal plant. Burns & McDonell, Kansas City, Mo., engineers, are drawing up plans. Estimated cost $85,000.

St. Francis plans extensions in municipal plant, and will take bids soon for one or two diesel-generator units, with auxiliary equipment. Cost about $85,000. E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers.

Board of Public Utilities, Kansas City, contracted S. Patti Construction Co., 1114 Broadway, Kansas City, Mo., for 2-, 3- and 6-story addition to municipal plant, 100x130 ft., and will begin superstructure soon. Cost about $500,000. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

KENTUCKY——State Department of Prisons, Frankfort, plans power house at new prison farm at LaGrange, Ky. Project will comprise group of one and multi-story buildings, and will cost about $1,800,000. State Engrg. Dept., Frankfort, will prepare plans.

NIAGARA'S POWER IS CONTROLLED HERE

Not a movie studio, but the attractive and interesting operating room of Ontario Power & Light Co., at Niagara Falls, Ont.

State Department of Public Welfare, Frankfort, plans power house at new state hospital and asylum at Danville, comprising several large multi-story units. A pumping plant will be installed for water supply. Cost about $2,150,000 through Federal aid. Work scheduled to begin in July. C. R. Logan, Frankfort, State Engineer, in charge.

Board of Trustees, Julius Marks Sanatorium, Georgetown Pike, Lexington, plans central-heating plant. Cost close to $120,000. Financing through Federal aid. Frankel & Curtis, Hernando Bldg., architects.

Paducah, plans central heating plant at new hospital in Avondale section, to replace Riverside Hospital damaged by flood waters several months ago. Cost about $500,000. Financing through Federal aid. Bids will be asked soon. E. T. Hutchins, Heyburn Building, Louisville, architect.

LOUISIANA——Iberia Sugar Co-Operative Association, 1454 Joseph St., New Orleans, J. J. Watson, president, plans power house at new cane sugar mill at New Iberia. Cost about $600,000.

Burrwood contracted Schramm, Inc., West Chester, Pa., for two diesel-generating sets for municipal electric plant.

Board of Directors, Charity Hospital of Louisiana, New Orleans, Fred W. Matthews, secretary, plans power house at new multi-unit hospital. Entire project will cost about $8,000,000. Financing through Federal aid. Weiss, Dreyfous & Seiferth, Maison Blanche Bldg., architects.

Charles Foti, Martinsville, heads project to construct and operate an ice-manufacturing and cold-storage plant on Washington St. Cost about $35,000.

Monroe plans improvements in municipal electric plant, with new generators and accessory equipment, two new boilers, and miscellaneous equipment. Bond issue of $1,500,000 being arranged.

MASSACHUSETTS——Board of Trustees, New England Baptist Hospital, 85 Parker Hill Ave., Boston, plans boiler house. Cost close to $60,000. D. D. Eames, 739 Boylston St., consulting engineer.

Liberty Mutual Insurance Co., Park Sq. Bldg., Boston, plans heating plant in new 10-story building at Berkeley and Stuart Sts. Cost about $2,000,000. Chester L. Churchill, 9 Newbury St., architect.

MICHIGAN——Detroit Edison Co., Detroit, started work in April on an extension of 8 bays to Delray Power House No. 3 turbine-room superstructure to eventually house three more turbo-generators, and an extension of boiler-room bays for six more boilers. Substructure for this work is now in place and temporary construction track work is in progress. Orders have been placed for three high-pressure boilers, the first to be ready for service by June 1, 1938.

Chevrolet Motor Co., 3044 West Grand Blvd., Detroit, plans power house at new automobile engine and parts plant in Tonawanda Township, near Buffalo, N. Y. Estimated cost over $2,000,000.

Ann Arbor has received low bid from Charles R. Wermuth & Sons, Birmingham, Mich., for water-softening plant for municipal waterworks at $313,967, and will award contract soon. Ayres, Lewis, Norris & May, Ann Arbor, consulting engineers.

Zeeland is arranging financing for $85,000 for municipal electric plant, to use diesel-generator units.

Consumers Power Co., Jackson, Daniel E. Karn, general manager, is considering steam-electric generating station at Saginaw Bay, Mich.

MINNESOTA——Board of Wright County Supervisors, Buffalo, plans boiler plant in new courthouse building. Fund of $200,000 through Federal aid. E. D. Corwin, Guardian Bldg., St. Paul, Minn., architect.

Board of Education, Duluth, plans new boilers and auxiliary equipment in power station at Jefferson School. Bids will be asked soon. Foster & Wahlberg, Medical Arts Bldg., consulting engineers.

MISSOURI——Boone County Co-operative Electric Assn., Columbia. R. A. Dinwiddie, secretary, plans steam-electric plant. Cost about $75,000. Financing through Federal aid. Baumes-McDevitt Co., Railway Exchange Bldg., St. Louis, Mo., consulting engineer.

Crown Cork & Seal Co., plans steam power house at new plant for subsidiary organization at Natural Bridge Ave., St. Louis. Entire project to cost about

$2,500,00. L. R. White, Jr., 10 West Chase St., Baltimore, Md., architect.

A. H. Beard Engineering Co., Inc., St. Louis, is preparing plans for a municipal light plant for Columbus, Miss. Estimated cost $280,273.

MONTANA —— Flathead Irrigation District, Ronan, D. A. Dellwo, secretary, plans electric-operated pumping plant near Polson for increased water supply. Cost about $110,000. Federal financing.

NEBRASKA —— Ak-Sar-Ben Natural Gas Co., Oxford, plans welded-steel pipe-lines from connection with main trunk system to Farwell and Ravenna. Control and distributing stations, and steel pipeline distributing systems will be installed. Company is also obtaining gas franchises at St. Paul, Burwell, Loup City and Ord. Cost over $250,000.

Haigler is concluding financing through Federal aid for $42,000 for proposed municipal electric plant, and plans to begin work soon. C. R. Fulton, 2327 S. 19th St., Lincoln, consulting engineer.

NEW HAMPSHIRE——Nashua plans boiler plant in new 3-story city hall building. Cost about $300,000. Wells, Hudson & Granger, Hanover, N. H., architects; R. D. Kimball Co., 6 Beacon St, Boston, Mass., consulting engineer.

OHIO——Euclid Doan Power Co., Inc., Cleveland, plans underground fan house. Ralph A. Spengler, 4614 Prospect Ave., engineer.

Lippincott Co., 42 Main St., Cincinnati, will soon begin construction of boiler house at new canning plant at Napoleon. Entire project will cost about $125,000. A. M. Kinney, Inc., Carew Tower Bldg., Cincinnati, consulting engineer.

Painesville will take bids soon for improvements in municipal electric plant, to include steam turbo-generator unit, 5,500-sq.ft. boiler, combustion-control apparatus, and auxiliaries. Cost close to $100,000. H. Ralph Hadlow, 700 Prospect Ave., and Frank O. Wallene, 17114 Ernadale Ave., both Cleveland, consulting engineers.

Bruckmann Co., Ludlow Ave. and Central Parkway, Cincinnati, plans 2-story power plant, 45 x 53 ft., at local brewery. Cost over $80,000. Tietig & Lee, 34 West Sixth Street, architects; Fosdick & Hilmer, Union Trust Bldg., consulting engineers.

Yorkville plans pumping station and water-softening plant for municipal water system. Bids will be asked soon for equipment.

Ohio City has asked bids for new municipal steam plant, and will begin work on project at early date. Cost about $41,000. Carl Simon, Van Wert, consulting engineer.

Berea plans extensions in municipal electric plant. Estimates of cost are being made. William C. Kammerer & Associates, Inc., Smythe Bldg., Cleveland, consulting engineer.

OKLAHOMA——Ponca City contracted Nordberg Mfg. Co., Milwaukee, Wis., for 2,500-hp. diesel engine direct-connected to 1,500-kw. generator, for municipal electric plant. Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

Pure Oil Co. recently let contract to B & M Construction Co. for 12-mile, 6-in., Lindewelded oil line near Okmulgee.

Continental Oil Co., Ponca City, has let contract to Osage Construction Co. for 37-mile, 8-in., Lindewelded oil line near Geneseo, Kan.

OREGON——Hood River Apple Growers' Assn., Hood River, is considering early construction of new multi-unit cold storage and refrigerating plant. Cost about $300,000.

Medford Ice & Storage Co., Medford, plans 1-story addition to cold storage and refrigerating plant, 65 x 77 ft. Cost about $30,000.

State Hospital Board, Salem, plans new power house at local State hospital. Project to cost over $500,000. Financing through Federal aid. Jones & Marsh, Woodlark Bldg., Portland, architects.

PENNSYLVANIA —— Firth-Sterling Steel Co., McKeesport, has completed plans for building a new warehouse in Detroit, which will double its present capacity.

Chambersburg plans improvements in municipal electric plant. Bids will be asked at early date. Financing through Federal aid.

TEXAS——Barnsdall Pipe Line Co., has let contract to Williams Bros. Corp., for 70-mile, 6-in., Lindewelded oil line to run from Placedo field in southern Texas to refinery to be built by Barnsdall Refining Co. near Corpus Christi.

Cortex Petroleum Corp., Palestine. plans boiler plant and air compressor station at new natural-gas plant in Cayuga oil field district, near Palestine. Cost about $100,000. Elliott Middleton. engineer in charge.

Willis plans installation of deep-well, motor-driven pumping machinery and auxiliary equipment, and 50,000-gal. elevated steel tank and tower for municipal water system. Garrett Engrg. Co., Houston, Tex., consulting engineer.

Gregory, Robinson & Spears, Inc., Paris, plans boiler house at new vinegar plant, 95 x 250 ft., at Dallas. Cost about $85,000.

WASHINGTON——Shell Oil Co., Westlake Ave. and Highland Drive, Seattle, has approved plans for new boiler house at bulk oil plant on Eleventh St., S. W. Superstructure will begin soon. Cost about $25,000.

Northwest Door Co., 1203 East D St., Tacoma, has approved plans for new boiler house at mill, 50 x 55 ft. Cost about $30,000.

WEST VIRGINIA——W. A. K. Co., operated by Godfrey L. Cabot Corp., Union Bldg., Charleston, W. Va., plans welded-steel pipe line from connection with main trunk line to Hinton, W. Va., with control station and operating facilities.

WISCONSIN——Eau Claire is considering installation of municipal hydro-station, for power supply for municipal waterworks pumping plant. Estimates of cost will be made soon. A. R. Garnock, city engineer.

Stevens Point plans electric-operated pumping plant in connection with new sewage-disposal works. Fund of $580,000 through Federal aid, Robert Cramer & Sons, 647 West Virginia St., Milwaukee, consulting engineers.

Allouez plans early purchase of deep-well pumping unit and other pumping machinery for new waterworks pumping station. A. E. McMahon Engineering Co., Menasha, is consulting engineer.

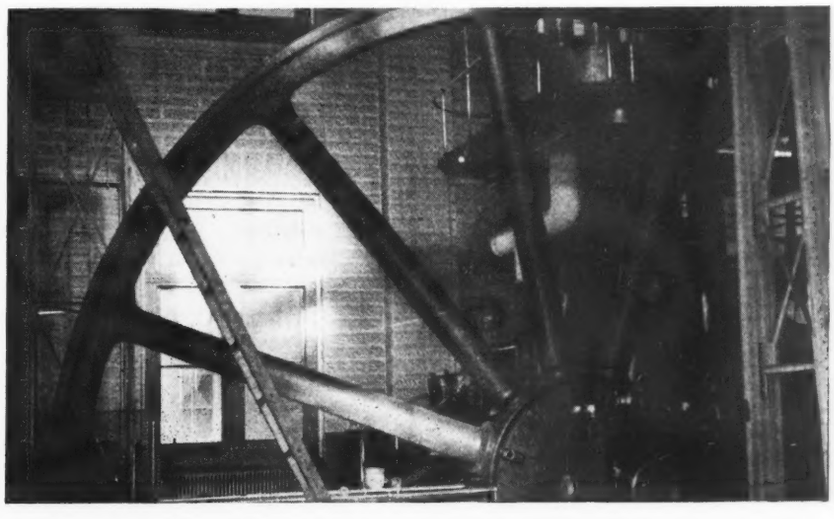
Chippewa Rural Electrification Assn., Chippewa Falls, plans steam plant. Cost over $250,000. Financing through Federal aid. E. B. Wayts, Tenney Bldg., Madison, consulting engineer in charge.

Inter-County Municipal Power District, Luck, Charles D. Mattson, attorney and representative, has preliminary plans for hydro-electric generating plant on St. Croix River at Kettle Falls, Wis., in connection with large flood-control project. Estimated cost $8,000,000. Financing through Federal aid. Wendell W. Cutcliffe, 739 Johnson St., N. E., Minneapolis, consulting engineer in charge.

WYOMING——Lusk has contracted Fairbanks, Morse & Co., Chicago, Ill., for diesel set and auxiliary equipment. Cost close to $40,000.

SOME FLYWHEEL, EH, 'SKEETER!

36-ft. diameter flywheel, claimed to be the country's largest, on an old 16,000,000-g.p.d. compound, walking-beam pump at Water Works in Louisville, Ky.



TOO FAR...

The Parable of the Seller's Market

Down home, our old odd-job man, Otis Smith, decided to raise some chickens. Now, Otis was a frugal cuss, and the amount those chickens ate sort of pained him. So he conceived the idea of mixing a little of his spare sawdust with their feed. A handful of sawdust to ten of feed was accepted by the chickens—in fact they thrived on it. So he stepped up the mixture to a quarter sawdust. Still no fuss from the hens, and egg production held up fine. By a process of alternate stepping up the sawdust percentage and watching, Otis finally decided to go whole hog and feed the hens all sawdust. Worked all right, s'far as he could tell, too.

But then Otis decided he wanted to put a hen to setting, so he'd get some chicks. All was well, 'til that batch of eggs hatched. Three chicks had wooden legs, and the rest were woodpeckers.

Otis had sort of cut off his nose to spite his face—he saved on feed, but all he got was some more sawdust producers. He didn't know when to quit. His story reminds me a lot of the way most of us engineers get along with salesmen.

For years now, times have been tight, and whenever any of us offered to buy anything, salesmen clustered around us, offering 'most anything just to get the order. Maybe we've gotten a little inflated because of it, gotten to thinking that manufacturers were designed for our special benefit.

But here comes spring—birds singing, everybody figuring on new Easter duds, and even the hired man sporting a new necktie. I get to thinking about a new coat of paint for the house and a couple of new things for the plant. But when I mention it, nobody seems particularly interested—it seems a lot of other people have the same idea, and salesmen have more business than they can handle. Business is booming, prices are going up, deliveries are poor, labor is restless, people are beginning to talk about the stock market again. Demand seems to have caught up with supply and passed it. We're in the midst of a seller's market.

This is the time when we'll see if Otis' force-feeding ideas work out. Some of us were considerate and didn't drive hard bargains when times were bad—let's see now if we made a mistake. If we didn't, the salesmen will go out of their way to get us what we need, returning favor for favor, earning our appreciation as we should have earned theirs a couple of years ago.

They can build plenty of good will, or plenty of something less desirable by the way they treat us now. And we can at least appreciate their efforts in our favor. It will be interesting to see how this parable ends.

George Edwards

GEORGE EDWARDS,
Engineer

A small motor may tie up your factory tomorrow

Casually accepting size as a measure of *importance* can lead to serious trouble in the use of electric motors. A *small* motor driving a conveyor, for instance, may tie up scores of machines if it fails and interrupts the flow of material and parts to these machines.

Thinking industrials do not stumble into this costly error. They insist on proven Motor Control for motors of *every* size. That is why

FOR SMALL MOTORS

Built to a standard of millions of operations with heavy solid silver twin-break contacts and the famous C-H eutectic alloy overload relay. Featured as standard equipment by responsible machinery builders and stocked by reliable independent electrical wholesalers. Cat. 9586 AAA.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Cutler-Hammer Bulletin 9586 Motor Control is so widely preferred for the smaller motors of Industry. Its many features of superior construction, its legacy of the widest engineering experience and its unequalled record of performance *must* recommend it to you. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus*, 1358 St. Paul Ave., Milwaukee, Wisconsin.

NEW BULLETINS

Valves—The Foxboro Co., Foxboro, Mass. 28-page bulletin No. 214 gives operating characteristics, specifications and dimensions of throttling and quick-acting "open-and-shut" controlled valves; complete line of auxiliary equipment.

Speed-Reduction Units — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., 8-page Bulletin DD-25-030, "Types SH and DH Speed Reducers," shows application, design and construction of single- and double-reduction units using single helical gears, anti-friction bearings and splash lubrication. Also included are speed-ratio and horsepower-rating charts.

Bearings — Randall Graphite Products Corp., 609-613 W. Lake St., Chicago, Ill. Catalogue lists inside and outside diameters and lengths of all standard bronze graphite bushings and sheave bearings; inside bearings shown in a marginal index for quick reference. Also briefly described are new reservoir bronze bushings and thrust washers, and Randall pillow blocks.

Diesel Engines—Stover Mfg. & Engine Co., Freeport, Ill. 12-page bulletin No. 38 describes 5- and 10-hp. vertical single-cylinder diesel engines.

Valves—The Kennedy Valve Mfg. Co., Elmira, N. Y. Folder bulletin No. 47 shows new line of bronze-bushed, iron-body, wedge-gate valves, with sectional views and classifications.

Scale and Corrosion Control—D. W. Haering & Co., 3408 W. Monroe St., Chicago, Ill. 16-page booklet, "Organic Methods of Scale and Corrosion Control," defines various theories employed in this field, explains control methods used today, and gives complete description of scale and corrosion removal using glucosates. Illustrated with quantity charts and formulas.

Condensate Drainer — The Coe Mfg. Co., Painesville, Ohio. 20-page catalog No. 903 describes drain for removing air and condensate from steam lines; available for 25 in. vacuum to 250 lb. steam.

Leather Belting—Chicago Belting Co., Green & Washington Sts., Chicago, Ill. 16-page catalog on tension-welded leather belting. Shows welding process and applications.

Temperature and Pressure Recorder—Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. "Die-Out" No. ND-1, cut to half size, swings open and reveals mechanism of Micromax recorder. Shown as basic single-point unit.

Temperature Relays—General Electric Co., Schenectady, N. Y. 4-page folder No. GEA-2525 on Type ICT self-reset relays for protecting a.c. machines and transformers against abnormal heating. Construction, operation and characteristics.

Statistical Bulletin—Edison Electric Institute, 420 Lexington Ave., New York, N. Y. Records of principal operations of electric light and power companies, historical summary for 1926 to 1936, showing source and disposal of energy, financial and income statements, 47 tables and charts. 45 pages.

Process Control—Bristol Co., Waterbury Co., Waterbury, Conn. 4-page folder bulletin No. 479 describes automatic process control for insuring uniform products.

Watthour Demand Meters—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 44-page catalog section No. 42-315 describes application and operation of types RW and RW-2 indicating demand meters with dimensions and wiring diagrams.

Transformers—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Bulletin 1186 on type SB "outage free-distribution" transformer discusses operation, how transient surges are diverted and protection methods, and construction details. 12 pages.

Motor Pumps—De Laval Steam Turbine Co., Trenton, N. J. 12-page Catalog BF-100 describes "motor-mounted" pumps. Centrifugal pump is mounted directly on electric-motor frame to form a 1-shaft unit. Rating tables and operating characteristics.

Packing—U. S. Rubber Products, Inc., 1790 Broadway, New York, N. Y. 112-page indexed manual gives engineering data on characteristics, recommendation charts, specific gravities, and applications.

Diesel Engines—Western Engine Corp., 1000 Alhambra Ave., Los Angeles, Calif. 8-page illustrated bulletin No. SD-100 showing specifications, ratings, dimensions and comparative costs for Type A engine.

Gaskets—Goetze Gasket & Packing Co., Inc., New Brunswick, N. J. 24-page booklet "Fifty Years of Experience"—a historical and photographic description of modern gasket design and manufacture. Extensively and unusually well illustrated.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ariz., Phoenix—Central Arizona Light & Power Co. plans addition to steam electric plant, 4 mi. west of Phoenix, $350,000, change of transmission lines to Avondale and Buckeye, Ariz., and installation new substation at Perryville $70,000, extensions and improvements to electrical distribution system lines $100,000, gas main replacements, new gas mains, meter office and sop equipment $174,500, new substation at Northwest Phoenix $34,000, rebuilding Sycamore Line to Prescott $10,000, addition to warehouse $16,000, purchase trucks and automobiles $28,000, new meters and transformers $15,000, construction new electrical service lines $10,000, purchase 8.8 mi. Roosevelt Irrigation Dist. lines $6,500. Total $814,000.

Idaho, Idaho Falls—City constructing municipal power plant on Snake River, at Mesa Falls, incl. 500 ft. concrete dam, near Heise, 1,250 ft. earth dike, relief labor. $338,000. W.P.A. project.

Idaho, Lewiston—Clearwater Valley Light & Power Assn. allotted $325,000 by Rural Electrification Administration to build 264 mi. line and generating plant to serve 900 customers.

Kan., Clay Center—City making power plant improvements. Burns McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Kan., McPherson — City, c/o L. Angerine, supt. Electrical Dpt., McPherson, plans power plant improvements, incl. furnishing new steam electric generator. $90,000. Application made to P.W.A. for funds. Burns & McDonnell, 107 West Linwood Blvd., Kansas City, Mo., engrs.

Kan., St. Francis—City plans 2 new diesel engine and units complete and improvements to present power plant building. $85,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Michigan—Consumers Power Co., Jackson, plans to be completed for power development to have ultimate capacity of 275,000 h.p. on Kalamazoo River, near Comstock and Camp Custer, to include dam across Kalamazoo River, fuel handling equipment and storage capacity for 1,000 carloads of coal, buildings, machine shop, storeroom, sub-station, also double circuit, 140,000 volt transmission line to connect with existing lines.

Michigan—Michigan State Hospital Comn., Lansing, plans 152 bed tuberculosis building, 52 room addition to Van Dusen Hospital; laundry addition at Kalamazoo; 300 bed receiving hospital at Pontiac; 300 bed receiving hospital at Traverse City; power plant employees building, addition to Cottage "O," at Newberry, all brick, steel, stone, and concrete construction. $2,961,000.

Mich., Highland Park—Dpt. Street Railways, St. Jean and Shoemaker Aves., Detroit, filed application with P.W.A. for grant to finance construction of heating plant in Highland Park Street Railway Comn. shops. $30,900.

Mo., Kansas City—Kansas City Power & Light Co., 1330 Baltimore St., plans constructing substation, $100,000.

Neb., Fremont—City making plans power-plant improvements. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Neb., Haigler—City plans light and power plant. $40,949. C. R. Fulton, Lincoln, engr. Applied for P.W.A. loan and grant.

Neb., York—Iowa-Nebraska Light & Power Co., Lincoln, plans constructing improvements for light and power plant to triple capacity, incl. purchasing two new 1,000 h.p. generators. $100,000. R. Graham, York, district mgr.

Nev., Las Vegas—City plans municipal power and light plant and distribution lines. $250,000 bond issue authorized. Engineer not appointed.

N. J., Belleville—Bd. Freeholders Essex Co., Hall of Records Bldg., Newark, plans by Epple & Kahrs, 150 Washington St., Newark new power plant and boilerhouse to house 3 water tube 300 h.p. boilers and generator set for isolation hospital. $175,000. Runyon & Carey, 31 Fulton St., Newark, engrs.

O., Bluffton—Central Light & Power Co., A. Robison, vice-pres. and genl. mgr., Findlay, plans high pressure steam generating plant to supplement company's plant in Findlay, will install new steam turbo-generator and other appurtenant equipment. $40,000. Private plans.

O., Columbus—City plans addition to existing municipal light and power plant by construction of powerhouse and installation of one 10,000 k.w. turbo-generator, one 12,500 sq. ft. boiler with necessary auxiliaries and control equipment and systems for handling coal conveyors and storage facilities. Dublin Rd. Est. about $1,000,000. P.W.A. will finance 30% of cost of project, such amount not to exceed $320,000. P. W. Maetzel, city engr.

O., Delphos—City Council authorized A. F. Weger, dir. Pub. Serv., to advertise for bids constructing light and power plant, incl. installation of equipment and wiring for transmission system. $300,000. C. Simon, Van Wert, engr.

O., Fairport — Municipality plans electric light and power plant and distribution lines. $150,000. J. M. Crabbe, Fairport, engr.

O., Lima—City plans constructing electric generating plant at municipal waterworks. $250,000. I. W. Barrows, Dayton, consult. engr.

O., Painesville—City making plans renovating municipal light plant, incl. installing new boiler, and renovating other boilers, additional structural changes, in set up of light plant. $100,000. H. R. Hadlow, 5005 Euclid Ave., Cleveland, engr.

O., Uhrichsville — City plans combination municipal light and waterworks plant. City solicitor has conferred with W. C. Kammerer, of W. C. Kammerer Associates, Cleveland, O., engineering firm, and Waldo Hortline, Dover, Ohio Engineer, on various types of plants.

Pa., Norristown — Commonwealth of Pennsylvania, Harrisburg, A. Colegrove, secy. Dpt. Property & Supplies, Harrisburg, plans by H. Lewis Shay, Packard Bldg., Phila., for state hospital buildings to exceed $2,000,000. Plans include boiler house and plant, $450,000.

Pa., Pennhurst — Commonwealth of Pennsylvania, A. Colegrove, secy. Dpt. Property & Supplies, Harrisburg, plans by G. L. Lovatt, Architects Bldg., Phila., state hospital, incl. 2 ward buildings $700,000, boiler house and plant $350,000, kitchen and laundry building $150,000, 3 cottages $24,000, fireproof construction, to be 2 stories high.

Pa., Seward—Pennsylvania Electric Co., W. G. Hickling, supt. and ch. engr., 35 Vine St., Johnstown, brick, steel light plant addition, to Berkebile Bros., 625 Swank Bldg., Johnstown. Owner also plans constructing 10 mi. 100,000 volt transmission lines, improvements to present generators, new 200,000 lb. boiler, new generator and annex to Seward plant in 1938. Total est, $2,500,000. E. M. Gilbert Eng. Corp., Reading, engrs.

Pa., Sunbury—Sunbury Impvt. Co., plans by Davis & Rice, Sunbury Trust Bldg., and soon takes bids 2 story, 72x200 ft., steel factory, unit, boiler house, etc.

Pa., Warren—Commonwealth of Pennsylvania, Dpt. Welfare, Capitol Bldg., Harrisburg, sketches by W. T. Monahan, Marine Bank Bldg., 901 State St., Erie, new units, alterations and additions to existing units, new power house, sewage disposal, etc. at State Hospital. $2,140,000. A. J. Warlow, ch. engr., Capitol Bldg. Application made to P.W.A.

Pa., Waverly — Municipality plans electric light and power plant. $100,000.

S. D., Custer.—State Sanitarium, State Bd. Control, Pierre, bill just passed by state legislature appropriating $15,000 for purchasing electric generator.

S. D., Flandreau—City voted $93,000 bonds constructing light plant. $168,770. P.W.A. project. J. W. Emberg, Madison, engr.

Wis., Milwaukee—Wisconsin Public Service Corp., 1029 Marshall St., Milwaukee, plans $1,570,000 construction budget for 1937, including dam and generating plant and substation at Tomahawk to cost $480,000.

Wis., Milwaukee—T. M. E. R. & L. Co., Milwaukee, takes bids about Apr. 15, constructing boiler plant, East Wells St. Est. exceeds $1,000,000 with equipment. F. Luber, c/o owner, archt.

Ont., Blind River—F. Deagle, Blind River, plans a complete report on proposed power rights on Blind River so that permission might be given to construct new power plant. Est. about $75,000.

Ont., Ottawa—Ottawa Electric Co., Ltd., Sparks St., W. H. Munro, mgr., plans constructing sub-station, Holmwood Ave., near Bank St. $80,000.

New Zealand, Wellington—Bids May 25, by Secretary Public Works Supplies & Tenders Committee, supplying oil immersed circuit breakers, four of 66,000 volts; seven of 110,000 volts; and one of 50,000 volts.

Mexico, Rio Grande—Mexican Corporation Ltd., plans by Head Office Staff, 49 Moorgate E. C., London, England, constructing power plant and purchasing hoisting and other equipment for Cantira and flotation plant at Rio Grande $2,000,000.

Siam, Bangkok—Ministry of Interior, through Public and Municipal Works Branch, preparing plans generating station of diesel type plant, $1,000,000***Those interested are advised to file names with Ministry and it is stated that considerable other electrical machinery may be purchased for existing plants.